UNIVERSITÉ DU QUÉBEC À MONTRÉAL

FROM GAMESTORMING TO MOBILE LEARNING: A CONCEPTUAL FRAMEWORK AND A GAMING PROPOSITION TO EXPLORE THE DESIGN OF FLOURISHING BUSINESS MODELS

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Jean-François, “Move forward !”

Maggy qui m’a dit : “Si tu commences, tu finis !”

AVANT-PROPOS

Il y a aujourd'hui 120 ans, le 24 avril 1895, le capitaine Slocum lève l'ancre. De 1895 à 1898, Josua Slocum fut le premier humain à réaliser un tour du monde à la voile, en solitaire, sur le *Spray*.

« Slocum conclut son récit par ces mots : « ...*Si le Spray n'a rien découvert au cours de son voyage, c'est parce qu'il n'y a sans doute plus rien à découvrir maintenant; d'ailleurs il ne cherchait aucun nouveau continent. Trouver sa route vers des pays déjà connus est un bon travail, et le Spray fit malgré tout une découverte : c'est que la mer la plus démontée n'est pas si terrible pour un petit bateau bien conduit... En examinant ce qui m'a conduit au succès, je vois un assortiment (pas trop complet...) d'outils de charpentier, une horloge en fer blanc, et des semences de tapissier. Mais ce qui compte le plus est l'expérience acquise pendant mes années de navigation, où j'appris avec ardeur les lois de Neptune, afin de m'y conformer exactement en traversant seul les océans...* »

(Wikipedia français, consulté le 19 avril 2015)

TABLE OF CONTENTS

AVANT-PROPOS XI

LIST OF FIGURES XIX

LIST OF TABLES XXIII

ABSTRACT XXVII

RÉSUMÉ XXIX

INTRODUCTION 1

CHAPTER I
FROM BUSINESS MODEL TO BUSINESS MODEL FOR A FLOURISHING BUSINESS FUTURE : CONCEPTUAL CHALLENGES

1.1 Introduction 9

1.2 BMs' Evolution over Time 10

1.2.1 (Digital) Value BM or VBM 12

1.2.2 Architectural BM or ABM 13

1.2.3 Sustainable BM or SBM 15

1.3 Conclusion 21

CHAPTER II
A JOURNEY INTO ACTION RESEARCH AND DESIGN SCIENCE

2.1 Introduction 23

2.2 Problem Statement 24

2.2.1 Practical Problem(s) 24

2.2.2 Research Problem 29

2.3. FAC Framework 32

2.3.1 Business Models as Cognitive Artefacts 33

2.3.1 Conceptualizing VBMs: Choosing an Artificiality Trajectory in Techno-Materiality Space 42

2.3.2 Conceptualizing ABMs: Moving from Techno- to Socio-Materiality 48

2.3.3 Conceptualizing BMSs/BMFs: Physical Materiality and Cognition Beyond Computation-Interpretation 51

2.4 Methodological Approach: Action Research and Design Science 64
2.5 Areas of concern 70
2.5.1 Teaching EMBA and Professional Students 70
2.5.2 Sustainable Development Unit in a Large Canadian City 71
2.6 Learning Objectives 72
2.6.1 Research Objectives 73
2.6.3 Research Propositions 74
2.7 Conclusion 77
CHAPTER III
BUSINESS MODEL CANVAS (BMC) VS. ORGANIZATIONAL ARCHITECTURE (OA): AN INVERTED CLASSROOM EXPERIMENT
3.1 Introduction 81
3.2 Business Models: Techno-materiality and Thin Design 84
3.2.1 BM Components: Thin and Hard Design 84
3.2.2 BM Success: Online Customer Interface and Thin Design 86
3.2.3 BMs as an Activity System 86
3.3 Organizational Architecture: Socio-materiality and Thick Design 86
3.4 Cognition Axis: Ways to Overcome Inertia 94
3.4.1 Mapping 98
3.4.2 Experimentation 98
3.4.3 Effectuation 99
3.4.4 Leading Change 99
3.5 Problem-Based Learning Experiment 100
3.6 Building or Playing with Categories: Ontology Building vs. Gamestorming. 105
3.6.1 Formal Ontologies, Canvases and Change Strategies 106
3.6.2 Informal Ontologies: When Communities of Knowledge are Ontologizing 110
3.7 Conclusion: BMFs as Simple Canvas or Complex Organizational Architecture? 113
3.7.1 Weak and Strong Sustainability 114

3.7.2 Paralleling Weak and Strong Sustainability with Thin and Thick Design 117

3.8 Conclusion: Designing BM with Strong Sustainability in Mind 119

CHAPTER IV
LOGIM@S©: A TABLE GAME TO LET CITY MANAGERS DISCUSS VALUE AND SUSTAINABILITY

4.1 Introduction 123

4.2 Logim@s©: A Table Game Architecture 127

4.2.1 One BMC Template 130

4.2.2 Three Kinds of Cards: City Discourses, SD-GRI and Other Cards (Abduction) 132

4.2.3 A Game Between Work and Theories of Work 134

4.3 Hypothesis on Cognition Axis 135

4.3.1 Computation 135

4.3.2 Induction—Deduction 136

4.3.3 Symbol-grounding, Situated Cognition and Interpretation 137

4.3.4 Abduction 141

4.3.5 Macrocognition Conditions 143

4.4 Observing Game Progression 144

4.4.1 Gamestorming Components Acted Upon by Players 147

4.4.2 Closing: Individual Debriefing 151

4.4.3 Closing: Informal Group debriefing 158

4.4.4 TUTOR 159

4.5 Conclusion 160

CHAPTER V
SYSTEM DESIGN: FROM THE LOGIM@S© GAME TO THE SUSTABD© GAMESTORMING PLATFORM

5.1 Introduction 163

5.2 Game Design Process for Gamestorming about F Practices 166

5.2.1 BM as Cognitive System: How BM Decomposition Fits the Cognitive System Levels 168

5.2.2 The Three Levels in a Cognitive System 171
5.3 SustAbd© as a New F Practices Generating Platform 184
5.4 Five Main UML Cases to Develop SustAbd© 187
5.4.1 UML Case 1: Evaluate Gaming Potential of a Place-based Event/Period with Incompatible Sustainability Discourses 188
5.4.2 UML Case 2: Find or Build a First Local Storyline 190
5.4.3 UML Case 3: Elicit Case Knowledge Using FAC (Flourishing – Artificiality – Cognition) Grid 193
5.4.4 UML Case 4: Build a Gamestorming Experiment (GE) 200
5.4.5 UML Case 5. Monitor a Gamestorming Experiment (GE) 204
5.5 Conclusion 206
CHAPTER VI
SUSTABDPLAY© VIRTUAL TUTOR SYSTEM DESIGN
6.1 Introduction 209
6.2 Serious Games vs. Mobile Learning: Smart Challenges 214
6.3 Situated System Design Through Cognitive Modeling 217
6.4 Backcasting Assistance/Factual Knowledge Use 235
6.4.1 Abduction Studio 237
6.5 FAC Grid Exploration through Three Dialogues 238
6.5.1 Dialogues Along the Main Axes 240
6.6 Conclusion 241
CHAPTER VII 245
CONCLUSION AND FUTURE RESEARCH 245
7.1 Introduction 245
7.2. Relevance of Contradictory Discourses as Change Drivers 247
7.3 Discourses as Part of Artificiality Trajectory 248
7.4 Abduction as Logical Mode 249
7.5 BMC and BMF as Conceptual Artefacts 250
7.6 Future Research: Implementing the FAC Framework 252

7.7 Contribution of this Research, Limits and Conclusion 256
BIBLIOGRAPHY 261

LIST OF FIGURES

Figure

Page

Figure 1.1 Growth and Composition of Venture Capital Investments in Nominal Dollars, 1991-2000 11

Figure 1.2 Incidence of 'Business Model' and Related Management Terms 12

Figure 1.3 The Three Waves of Corporate Environmentalism, 1960-2010 15

Figure 1.4 The Sustainability Movement Nears a Tipping Point 16

Figure 1.5 BCG Framework for Analyzing Business Models 18

Figure 2.1 Action Research Approach following Checkland (1985), Baskerville & Wood-Harper (2016) 24

Figure 2.2 Illustration of Lack of Understanding and Lack of Capabilities to Design Sustainable BMs 31

Figure 2.3 BMs, BMSs and BMFs as Cognitive Artefacts 34

Figure 2.4 Illustration of Three Stances (from Dennett) Considering an Artefact (iPhone) and a Cognitive Artefact (BMC) 36

Figure 2.5 The FAC Research Framework (Flourishing – Artificiality – Cognition) 38

Figure 2.6 From Cube 1: Three Challenges from the Physical Environment 40

Figure 2.7 Shared Economy and Circular Economy on the FAC Framework 49

Figure 2.6 Cognition and Sustainability Approaches 59

Figure 2.8 FAC 72 Cubes to Capture Elements for a BM/BMF 60

Figure 2.9 The General Methodology of Design Research 67

Figure 2.10 The Stages of ADR 69

Figure 2.11 Two Interventions in an EMBA Classroom 71

Figure 2.12 Playing LogiM@s© with SD Unit Managers 72

Figure 3.1 Cognition Intensity from Techno- to Socio- to Physical Materiality 82

Figure 3.2 Using BMC for Zumba Case 85

Figure 3.3 The Organizational Architecture (OA) Approach: From Abstract Vision to Concrete Platform 87

Figure 3.4 BM Design Approach Compared to OA Approach 91

Figure 3.5 Four Contexts and Four Ways to Generate a Business Model 97

Figure 3.6 Four Teams' Concentric Maps: Actions, and Objects (in French) 103

Figure 3.7 Sustainability Science Ontology 107

Figure 3.8 BMS vs. BMF Designs 118

Figure 3.9 BMC, Gamestorming and Learning Corridor 119

Figure 3.10 Thin BMS Design vs. Thick BMF Design 120

Figure 4.1 Logim@s©: A Table Game Architecture 128

Figure 4.2 Four Key Explicit Dimensions in the Logim@s© Game 130

Figure 4.3 BMC Template to Illustrate How Sustainability Should Take Place in a Highway Interchange Project 131

Figure 4.4 Deduction and Induction as Logical Modes in Sustainability Domain 137

Figure 4.5 Three Periods in Gamestorming 144

Figure 4.6 The Game's Soundtrack 145

Figure 4.7 Players During Opening Period 146

Figure 4.8 Gamestorming Elements Acted Upon by Players 148

Figure 4.9 Transferring OO's Analysis onto the BMC Template 152

Figure 4.10 OO Player's Full Profile on Three Axes Model 153

Figure 4.11 RR Player's Full Profile on Three Axes Model 154

Figure 4.12 TT Player's Full Profile on Three Axes Model ... 155
Figure 4.13 Transferring TT's Analysis onto the BMC Template ... 156
Figure 4.14 Transferring VV's Analysis onto the BMC Template ... 156
Figure 4.15 VV Player's Full Profile on Three Axes Model ... 157
Figure 4.16 Vygotsky's (1987) Theory of Double Stimulation ... 161
Figure 5.1 Activities at the Fuzzy Front End of Product Innovation ... 165
Figure 5.2 A Visual Mnemonic for the Levels in Smith's Game Design Metatheory 168
Figure 5.3 The Osterwalder-Pigneur BM Canvas ... 170
Figure 5.4 Game Design as Cognitive System ... 172
Figure 5.5 Observed Emotional Transitions and Their Hypothesized Causes ... 183
Figure 5.6 A System Design for the SustAbd© Core and Periphery Architecture 186
Figure 5.7 Resolute Co. Case Mapped on an FAC Grid ... 193
Figure 5.8 Three Periods in Gamestorming ... 204
Figure 6.1 From Human Tutor to Embedded Robot as Tutor ... 211
Figure 6.2: Four Gaming Concepts to Implement SustAbd© ... 216
Figure 6.3: Computer-Aided Mobile Learning in the LogiM@s©/Sustabd© Case ... 217
Figure 6.4 Tracking Cards 'At Hand' ... 222
Figure 6.5 An Intelligent Environment for Sustainability ... 224
Figure 6.6 UML Use Cases To Build SustAbdPLAY© ... 230
Figure 6.7 iStar 1: Getting to Know Each Other and Connected Communities ... 233
Figure 6.8 Analysis/Synthesis: Asymmetry of Human Thought ... 236
Figure 6.9 The Universal Abduction Studio ... 238
Figure 6.10 SustAbdPLAY©: Three Dialogues Around BMF ... 241
Figure 7.1 BMC and BMF Google Search Images ... 250

Figure 7.2 Improving the FAC Intelligent Environment 253

Figure 7.3 SustAbdPLAY© Screen Combining iStar 2.0 and FAC Cubes 254

Figure 7.4 Displaying Data from Specific Cubes 255

LIST OF TABLES

Table

Page

Table 2.1 *A Priori* Distinction between BM and BMF Design 26

Table 2.2 Adaptation of Krippendorff's Artificiality Trajectory to the FAC Framework 39

Table 2.3 Physical Materiality: Artificiality Trajectory and Cognitive Modes 56

Table 2.4 Similarities of Fundamental Characteristics of Action Research and Design Science 66

Table 2.5 Summary of Research Propositions 78

Table 3.1 Fine vs. Dense Design (Adapted from Sack, 2008)................................. 84

Table 3.2 Business Model (BM) vs. Business Platform Model (BPM)................... 92

Table 3.3 The Four Pillars of Osterwalder's Ontology (2004)............................. 108

Table 4.1 Moore's (2007) 'Abductive' Sentences Adapted to Krippendorff's (2007) Artificiality Trajectory.. 124

Table 4.2 Card Description for Logim@s© Game 132

Table 5.1 UML Case 1: Events Flow.. 189

Table 5.2 Storyline Components and Evolution, from Moore (2007)................... 191

Table 5.3 UML Case 2: Events Flow.. 192

Table 5.4 Twelve 'Abductive' Sentences by Moore (2007) on the Physical Materiality Axis 195

Table 5.5 Differences Between Deduction, Induction and Abduction 198

Table 5.6 UML Case 3: Events Flow.. 199

Table 5.7 UML Case 4: Events Flow 202

Table 5.8 UML Case 5: Events Flow 205

Table 6.1 Levels of Intelligence and Task Type 214

Table 6.2 Three Perspectives About Situated Cognition (Clancey, 1997: p. 23) .. 220

Table 6.3 The Taxonomy Table by Anderson et al. (2001) 226

Table 6.4 Example of a Simple Questionnaire 234

Table 6.5 SustAbdPLAY© Enabling Three Dialogues 239

Table 7.1 Sustainability Artificiality Trajectory and BMI 249

Table 7.2 Tutor Challenges and BMs/BMFs as Cognitive Artefacts 251

Table 7.3 Revised Summary of Research Propositions 258

LIST OF ABBREVIATIONS, SIGLES AND ACRONYMS

ABM	Architectural Business Model
AI	Artificial intelligence
BCG	Boston Consulting Group
BM	Business model
BM-G	Business model gamification
BMC	Business model canvas
BMF	Business model for a flourishing
BMI	Business model innovation
BMO	Business model ontology
BMS	business model for sustainability
BPM	Business platform model
CAD	Computer-assisted design
CERES	Coalition for Environmentally Responsible Economies
CM	Cognitive modeling
CM	Community member
CTM	Computational theory of mind
DE	Domain expert
DMO	Démarche Méthodologique Ontologisante
EA	Enterprise architecture
EAM	Enterprise architecture management
EDF	Électricité de France
EIS	Executive Information System
FAC	Flourishing Artificiality Cognition
FBPM	Flourishing business platform model
FSC	Forest Stewardship Council
GD	Gamestorming designer
GE	Gamestorming experiment
GES	Gaz à effet de serre
GRI	Global Reporting Initiative
GSSD	Global System for Sustainable Development
HP	Hewlett-Packard

ICT	Information and communications technology
IPS2	Industrial Product–Service Systems
iStar, i*	Social Modeling Approach
IS	Information system
KM	Knowledge management
KPI	Key Performance Indicators
MBA	Master of business administration
MIS	Management information system
MIT	Massachusetts Institute of Technology
NGO	Non-governmental organization
NRC	National Council of Scientific Research
OA	Organizational architecture
OAO	Organizational architecture ontology
OD	Organizational design
OM	Organizational modeling
OO	A player in LogiM@s© game
pistar	An iStar dedicated Software
PL	Player
PW	Pinnacle West
QOL	Quality of life
RR	A player in LogiM@s© game
SA	Societal Architecture
SD	Sustainable development
SME	Small and Medium Enterprises
SMR	Sloan Management Review
SS	Sustainability Science
SSBM	Strongly sustainable business model
SSBMG	Strongly sustainable business model group
SSO	Sustainability science ontology
SUC	System Under Consideration
SUS	System Under Study
TT	A player in LogiM@s© Game
UML	Unified Modeling Language
VBM	Value Business Model
VCR	Video recoder (made by Panasonic)
VV	A player in LogiM@s© game

ABSTRACT

Chapter one presents the BM's origins, a result of a clash between corporate finance and corporate strategy at the birth of the first spreadsheet software in the 1980s. From then on, the chapter proposes to consider the BM's story for three periods: first, digital value BM, second, architectural BM and, third, sustainable BM. But academicians and practitioners don't agree on a definition for a sustainable BM. There is an opposition between weak vs strong approaches; in this thesis, the Ehrenfeld (2005) definition and commitment to a flourishing future approach is adopted, producing a new BM occurrence, BMF or business model with a flourishing future. The conclusion shows that digital value BM implies computing as a cognitive mode, architectural BM is more associated with an interpreting mode, while BMF should be designed based on situated cognition and macrocognition.

Chapter two is dedicated to literature review, conceptual framework building and research problem definition. This chapter contrasts BMs developed under a more traditional computational-interpretative cognitive view with BMF building calling for new preconditions, namely situated cognition and macrocognition. In this way, actors design a BMF through their sensorimotor interface to socio- and physical materiality where meaning emerges from multiple interactions. Also, a BMF becomes a shared public object open to social competence development in a situation where macrocognition principles apply. Thus, the FAC (Flourishing – Artificiality – Cognition) framework is produced to better understand differences between BM, sustainable BM (SBM) and BMF.

Chapter three takes stock of an MBA classroom teaching/learning experiment in which students had to handle—in the same course—both a Business Model Canvas (BMC) and a rather abstract organizational modeling (OM) (Morabito and al., 1999) in connection with knowledge management (KM) approaches. This learning experiment is a case of thick design inside an inverted classroom to explore the following idea: If more socio- and physical materiality is part of domain design, the cognition requirements and the cognitive load are more complex. The chapter concludes by associating weak sustainability with thin design and strong sustainability with thick design and by synthetizing key elements such as cognitive

processes, ontologies contributions and computer-based support in both the business model canvas (BMC) and organizational architecture (OA) approaches.

Chapter four delves more deeply into greening issues. This chapter presents a table game experiment with Logim@s© that occurred in the sustainability division of a large Canadian city: the four players were sustainability directors and professionals. The game is based on Steven Moore's book (2007), which exposes storylines, logical modes and discourses that enable three very different cities (Curitiba, Austin and Frankfurt) to deploy sustainability leadership. A thick design challenge lies at the heart of the experiment: how can a player connect the BMC approach with each city's contradictory discourses and 'abductive' sentences on the physical materiality axis? Are the players in an inductive/deductive logical mode, or will they move on to abductive mode?

Chapter five examines how Logim@s© could become an open gamestorming platform, namely SustAbd©. This chapter has two parts: the first part is a reflection on the game design process to justify a platform-architecture approach made up of the SustAbd© core and the SustAbd© periphery, and a second part, where five key UML use cases are proposed.

Chapter six builds on this researcher's experience as a human tutor in inverted teaching and gamestorming experiences. The intent in this chapter is to adopt cognitive modeling (CM) as an approach devised to replace a human tutor with an embedded robot. This chapter continues with thoughts about situatedness and situated robots borrowed from Clancey's (1997) work on situated robots. Those ideas make it possible to devise SustAbdPLAY© in accordance with situatedness and macrocognition by making distinction between individuals devising a new course of actions inside a community compliant with macrocognition conditions and individuals acting under instructions from others inside a hierarchy. Then new UML use cases are derived like getting to know each other and establishing a player's community.

Chapter seven caps off the thesis by outlining lessons learnt, the limits of the study and future research and offering a general conclusion.

KEYWORDS: Business Model, Sustainability, Cognition, Materiality, Gamestorming, Mobile Learning, Action Research, Design

RÉSUMÉ

Cette démarche de thèse débute par la mise au point d'un cadre conceptuel à propos de la durabilité ('sustainability') et du MA (modèle d'affaires), pour cadrer une recherche sur la définition et la conception de MA durable. Grâce notamment à Ehrenfeld (2005), le MAF (modèle d'affaires pour un avenir florissant ou 'flourishing future') est défini. La question est maintenant de savoir comment introduire les gestionnaires à la théorie et la pratique du MAF ? Quelle est la nature de l'effort cognitif exigé ? Et l'apprentissage peut-il être stimulé par le 'gamestorming' en proposant un espace d'apprentissage ouvert à la formation de nouveaux concepts.

Le premier chapitre présente les origines du MA suite à l'affrontement dans les années 1980 entre la finance d'entreprise et la stratégie d'entreprise lors de la naissance du premier logiciel de tableur. Dès lors, le chapitre un propose d'envisager l'histoire du MA en trois périodes : d'abord le MA pour la valeur numérique, ensuite, le MA architectural et finalement, le MA durable. Mais les académiciens et les praticiens ne s'entendent pas sur la définition de MA durable. Il existe une opposition entre les approches faible et forte. Nous adoptons dans cette thèse la définition et l'engagement d'Ehrenfeld (2005) à un avenir florissant, définissant ainsi le MAF ou modèle d'affaires (pour un avenir) florissant. Le chapitre un montre que le MA pour la valeur numérique implique le calcul comme un mode cognitif, le MA architectural est plus associé l'interprétation comme mode cognitif, tandis que MAF devrait être conçu grâce à la cognition située et à la macrocognition.

Le chapitre deux oppose le MA développé sous une vision cognitive plus traditionnelle de computation-interprétation à la construction du MAF exigeant de nouvelles conditions préalables nécessaires à la cognition située et à la macrocognition. De cette façon, les acteurs conçoivent un MAF via leur interface sensorimotrice où le sens se dégage de multiples interactions avec la matérialité sociale et la matérialité physique du modèle. Aussi un MAF devient un objet public partagé, ouvert au développement de la compétence sociale dans une situation où les principes de macrocognition s'appliquent.

Le chapitre trois fait le bilan d'une expérience d'enseignement / apprentissage avec une classe d'étudiants au MBA dans laquelle les étudiants devaient gérer dans le même cours, à la fois le canevas dédié au MA (CMA) et une modélisation

organisationnelle plutôt abstraite reliée à la gestion des connaissances (Morabito et al., 1999). Cette expérience d'apprentissage est un cas de conception dense ('thick design') à l'intérieur d'une salle de classe inversée qui permet d'explorer l'idée suivante: si la matérialité sociale et physique fait partie du domaine de conception, les exigences de la cognition et la charge cognitive seront plus lourdes. Le chapitre se termine en associant durabilité faible avec un design mince ('thin') et la durabilité forte avec la conception dense ('thick').

Le chapitre quatre plonge plus profondément dans les questions de durabilité. Ce chapitre présente une expérience jeu avec Logim@s© qui s'est produite dans la division du développement durable d'une grande ville canadienne : les quatre joueurs étaient gestionnaires de développement durable ou professionnels dans le domaine. Le jeu est basé sur le livre de Steven Moore (2007) qui expose les scénarios, les modes logiques et les discours qui permettent à trois villes très différentes (Curitiba, Austin et Francfort) de déployer leur leadership en matière de durabilité. Un défi de conception dense est au cœur de l'expérience : comment un joueur peut-il utiliser l'approche CMA alors que des discours contradictoires risquent de le bloquer cognitivement ? Les joueurs sont dans un mode logique inductif / déductif. Vont-ils passer en mode abductif?

Le chapitre cinq examine comment le jeu Logim@s© pourrait devenir une plate-forme ouverte de gamestorming, appelons-la SustAbd©. Ce chapitre comporte deux parties : la première partie est une réflexion sur le processus de conception de jeu pour justifier une approche plate-forme d'architecture composé du noyau SustAbd© et de sa périphérie, et une seconde partie, où cinq cas d'utilisation UML sont proposés.

Le chapitre six s'appuie sur l'expérience du chercheur comme un tuteur humain dans les expériences d'enseignement inversé et de 'gamestorming.' Le but de ce chapitre est d'adopter la modélisation cognitive (MC) comme approche pour remplacer un tuteur humain par un robot 'situé.' Ce chapitre se poursuit avec des développements au sujet du caractère situé des robots. Ces idées permettent de concevoir SustAbdPLAY© conformément au caractère situé et aux conditions de macrocognition propres au design d'un MAF. La modélisation sociale avec iStar permet de clarifier la conception.

Le chapitre sept termine la thèse. Il décrit les leçons apprises, les limites de l'étude ainsi que la suggestion de recherches futures. Une conclusion générale clôt le chapitre.

MOTS-CLÉS: Business model, modèle d'affaires, soutenabilité, développement durable, cognition, matérialité, gamestorming, apprentissage mobile, recherche action, design

INTRODUCTION

Compared to the strategy concept, a business model (BM) seems to be an abstract artefact detached from any organizational context. In contrast to the inherent subjectivity of the strategy concept, a BM reaches a kind of objective status because it is computable: in the end, a BM, as a mix of corporate finance and corporate strategy formalized within a spreadsheet, generates costs and revenues. With this in mind, this thesis explores the interactions between a BM, the physical environment and cognition.

Why add physical environment and cognition to the mix? For a person who holds a Ph.D. in Business Administration and is a professor at a Business School, taking stock of sustainability penetration at the heart of corporate life is encouraging. But when I think more deeply on the current situation, I see the birth and evolution of a kind of 'green' management that's constrained and limited inside organizational hierarchies determined to prove the reality of their 'green façade.' The stakes are high; sustainability discourses are everywhere. The VW Group demonstrated its commitment to sustainability on its corporate website, was ranked first—in 2013—on the Dow Jones Sustainability Index for automakers sector, and its CEO Winkerton stated in the 2014 Sustainability Report: "Our business is no longer just about the technical aspects like horsepower and torque. We have learned that sustainability, environmental protection, and social responsibility can be powerful value drivers."[1] Then, in fall 2015, came the VW *dieselgate* in the U.S. regarding the TDI motor.

[1] Monti, C. et al. (2016). Volkswagen's Clean Diesel Dilemma. WDI Publishing, University of Michigan, Case 1-430-484.

Reading about the VW case[2] shows us that: First, VW had a well-developed CSR (Corporate Social Responsibility) function; second, a leader declared that VW was becoming a world leader in sustainability; and, third, VW received the 'Green Car of the Year' (2009) label for the Jetta TDI and was ranked among the best companies in terms of sustainability.

So, what went wrong? First, 'sustainability' is so a vague concept and word that we—like Ehrenfeld (2008)—must back off from using the word. Second, a BM cannot be really 'green' or flourish inside a hierarchy where it must generate the economic and strategic drive for strategists and shareholders looking for returns. Instead, the 'green' or flourishing dimension as defined by Ehrenfeld (2008) should be shared by different categories of actors inside and outside the hierarchy. 'Green' mental states should be shared by people with suppliers, customers and stakeholders across enterprises inside a business ecosystem. The appeal that ecological transparency has for customers illustrates such a 'green' mental state. And a growing awareness of the physical limits of the planet, computed by ecological footprint measurement, is also a sharable mental state. In defining the concept of macrocognition as a shared mental state, Huebner (2013) offers a way to disentangle the tensions—and fallacies—between the BM and the hierarchy that leads to the development of 'green facade'. Quoting Huebner (2013): "Macrocognition cannot happen inside a hierarchy."[3]

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[2] Frederick, A. & Barbara, M. (2016). op. cit.

[3] I am very indebted to Bryce Huebner for a conversation about cognition and sustainability in/out hierarchy in Montreal in October 2016 over a couple of espressos.

The design of a flourishing BM is like unchartered territory. If a few authors give some indications regarding the design of a new business model, only a few papers are considered as explicitly bringing sustainability to a BM. From a cognitive science angle, the objective of this thesis is to underline the role of (inter)subjective invariants (i.e. values, beliefs, attitudes…) vs. external invariants (i.e. fixed categories) in a BMF design where computation offers a too limited view but situated cognition is key. The goal is the specification of an architectural target using an original framework enabling the design of a game that facilitates collaboration and macrocognition between actors often experiencing incompatible visions and diverging interests but belonging to the same ecological space. What are the options for designing such an intelligent environment?

At least four types of intelligent environments are already deployed for sustainability training. First, sustainability science ontology could be the heart of an intelligent tutorial system. Second, the serious games approach could be chosen as games are developed to train managers to *Global Reporting Initiative* (GRI)[4] reporting practices. Third, gamestorming with the BMC is the approach behind sustainable BMs developed with the SSBMG.[5] Finally, situated cognition can be applied to mobile learning.[6] In this thesis, I first try to become acquainted with gamestorming to generate specifications for a mobile learning system enabling situated cognition and

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[4] See: https://www.globalreporting.org/Pages/default.aspx

[5] See: http://slab.ocadu.ca/group/strongly-sustainable-business-model-group-ssbmg.

[6] Giusti, L., Pollini, A., Brunnberg, L. & Casalegno, F. (2012). En Plein Air: A Mobile Learning Approach for Sustainability Education in the Wild. International Journal of Mobile Human Computer Interaction (IJMHCI), 4(2), 44–58.

macrocognition. However, the projected system should relate to a sustainability science ontology.

Literature on the BMF subject is still under development. In Toronto, Canada, at OCAD University, work by professor Nabil Harfoush,[7] Antony Upward[8] and other members of the Strongly Sustainable Business Model Group (SSBMG) started being published around 2009. In 2013, Florian Lüdeke-Freund, then a young researcher in the field, defended his Ph.D. dissertation at Leuphana Universität Lünenburg (Germany) entitled "*Business Models for Sustainability Innovation: Conceptual Foundations and The Case of Solar Energy*." Lüdeke-Freund's thesis was based on five previous publications.[9] When I started writing this thesis in 2012, I was not

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[7] Harfoush, Nabil. "Developing Sustainable Business Models." In Disrupt Together: How Teams Consistently Innovate. Eds. Stephen Spinelli and Heather McGowan. Upper Saddle River, New Jersey: Pearson Education, 2013. PP.167-78.

[8] Upward, A. (2013). Towards an Ontology and Canvas for Strongly Sustainable Business Models: A Systemic Design Science Exploration. (Masters of Environmental Studies / Graduate Diploma in Business + Environment, York University, Faculty of Environmental Studies and Schulich School of Business), http://hdl.handle.net/10315/20777.

[9] (1) Boons, F. & Lüdeke-Freund, F. (2013): Business models for sustainable innovation: State-of- the-art and steps towards a research agenda, Journal of Cleaner Production, Vol. 45, 9-19.

(2) Hansen, E.; Lüdeke-Freund, F.; West, J. & Quan, X. (2013, in review): Beyond technology push vs. demand pull: The evolution of solar policy in the U.S., Germany and China, submit- ted to Research Policy.

(3) Lüdeke-Freund, F. (2013, forthcoming): BP's solar business model: A case study on BP's solar business case and its drivers, Int. Journal of Business Environment.

(4) Lüdeke-Freund, F. & Loock, M. (2011): Debt for brands: Tracking down a bias in financing photovoltaic projects in Germany, Journal of Cleaner Production, Vol. 19, No. 12, 1356-1364.

(5) Schaltegger, S.; Lüdeke-Freund, F. & Hansen, E. (2012): Business cases for sustainability: The role of business model innovation for corporate sustainability, Int. Journal of Innova- tion and Sustainable Development, Vol. 6, No. 2, 95-119.

aware of SSBMG's work and I had only in hand a thesis proposal written by Florian Lüdeke-Freund, found on the web. Members of the SSBMG may find my thesis quite orthogonal with their beliefs and their approach when I present BM design using the BM canvas (BMC) as a design stance as opposed to a physical stance. My observations were made only in my MBA classroom, and I don't want to generalize. I admit also that I have no training in BM design using the BMC.

This thesis was submitted to the UQAM, Faculty of Sciences, on April 21, 2015 and defended on September 28, 2016. The jury was composed by professor Nabil Harfoush (OCAD, Toronto) as external member, professor Serge Robert (UQAM, Dept. of Philosophy), professor Hakim Lounis (UQAM, Dept. of Computer Science) as director of the Ph.D. Program in Cognitive Informatics, and my two co-advisors, professor Roger Nkambou (UQAM, Dept. of Computer Science) and professor Pierre Poirier ((UQAM, Dept. of Philosophy). After the defense, I had the opportunity over two months to make some minor corrections and adjustments to comply with jury members' remarks.

In December 2015, thanks to an invitation by professor Harfoush and Antony Upward from SSBMG (OCAD, Toronto), I made a web presentation of my thesis to SSBMG members. In June 2016, I had the opportunity to present a paper at the *New Business Models* conference organized by professor Jan Jonker at Toulouse Business School (TBS) where I met Florian Lüdeke-Freund and a great number of deeply committed members of that researcher's community, including Jan Jonker and Nancy Bocken.

This thesis is not a thesis made up of articles, but its chapters are partly based on the following papers and conference proceedings:

- Lejeune, A. Poirier, P. 2016. Business Models as Cognitive Artefacts, *New Business Models Conference*, Toulouse, Toulouse Business School, June 14-16.
- Lejeune, A. Poirier, P. 2014. 'Green' Business Model Design: A Concept of Three Dialoguing Robots, *The ISPIM Americas Innovation Forum 2014*, Montreal, Canada, October 5-8.
- Lejeune, A. Nkambou, R. 2013. A Table Game to Elicit Green Capacities in Business Models, *The XXIV ISPIM Conference – Innovating in Global Markets: Challenges for Sustainable Growth*, Helsinki, Finland, June 16-19.
- Lejeune, A. 2013. An Agenda for a Small Turing Test: Choosing Between Big Data and Small Data to Develop a Sustainable Business Model. An invited position paper to the *World Summit on Big Data and Organization Design*, Paris, May.
- Lejeune, A. 2012. Business Model Innovation with Weak or Strong Sustainability In Mind. Paper presented at the ISPIM, *International Society for Professional Innovation Management*, Barcelona, Spain, June 17-20.
- Lejeune, A. 2012. Green Organizational Architecture: What Could It Be? Paper presented at the *Workshop on Information and Organizational Architecture* (dirs.: Prof. Richard M. Burton and prof. Charles C. Snow), EIASM, Brussels, Belgium, March 19-20.

At the end of 2011, I also started a blog entitled 'Green Organizational Architecture' (http://alejeune49.blogspot.ca).

The practical problem for managers and students is to design and implement a BMF, with strong sustainability in mind, and this thesis' hypothesis is that usual BM design through gamification doesn't fit BMF design requirements because BM gamification is conceived without macrocognition/situated cognition or fluid navigation on artificiality axis and in a context of techno-materiality. This insight was the first step on the research journey.

CHAPTER I

FROM BUSINESS MODEL TO BUSINESS MODEL FOR A FLOURISHING BUSINESS FUTURE : CONCEPTUAL CHALLENGES

1.1 Introduction

If a sustainable (green) business model (BM) design story were presented to an EMBA classroom, the challenge would be to synchronize moving targets or moving concepts over time. 'BM,' like sustainability, means different things to different people, and the concatenation of the two terms may lead to disputed sense-making and fuzzy greening strategies. 'BM' initially referred to business modeling for computer analysts (Kilov, 2002), then came to designate a tool to compute and find selling arguments for e-business ventures, and lately it has come to mean 'something' more universal (a canvas, a model, a market device, etc.) to rethink and compute value creation/capture by a firm or a set of firms organized inside an alliance in a business ecosystem. At its roots a BM borrows from computer science and organizational design, process analysis, applications design, the Internet, the web and e-ventures, meaning digital strategies to create/capture value. During the design process or later during the implementation phase, a BM is something inside investors' and managers' minds, something that is in the realm of cognitive science.

The reasons why BMs came to designate a tool to compute and find selling arguments for e-business ventures are both theoretical and practical. Theoretically, following Copeland et al. (1990: p. ix):

> In the last decade, two separate streams of thinking and activity—corporate finance and corporate strategy—have come together with a resounding crash. Corporate finance is no longer the exclusive preserve of financiers. Corporate strategy is no longer a separate realm ruled by CEOs. The link between strategy and finance has become very close and clear.

Practically, Copeland et al. (1990) underline the role of "computing technology and analytical techniques that make it easier than ever before to identify potential targets" for mergers and acquisitions (pp. 18-19). Computing technology meant first and foremost the use of the VisiCalc software, a software developed by Dan Bricklin and inspired by a BM design problem:[10]

> Then a first-year Harvard Business School (HBS) student, Bricklin watched as a professor sketched out a complex business model, and immediately saw the problem — changing a single parameter meant laboriously recalculating subsequent entries. It was then that inspiration struck. Why not let a computer do the tedious work for you?
>
> That inspiration eventually became VisiCalc, a pioneering electronic spreadsheet and a progenitor of programs like Miscrosoft Excel. Released in 1979, the program is widely credited for helping to transform the personal computer from a toy for hobbyists into an indispensable business tool.

1.2 BMs' Evolution over Time

All BM analysts agree the birth of BMs occurred in the mid-nineties in association with Internet and doc.com phenomena. This was a period of heavy investments in new Internet ventures by venture capitalists, and BMs became the plain new language net entrepreneurs and venture capitalists used to communicate with each other. From 1994 to 2000, close to 100 billion dollars were invested in dot.com ventures and internet infrastructures in the US only. At that time, corporate and business strategy

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[10] http://news.harvard.edu/gazette/story/2012/03/a-vision-of-the-computing-future/

as disciplines were hesitant and vacillating between two poles: positioning vs a resource-based view (Seni, 2013). The tsunami of dot.com projects (Figure 1.1) coming from nowhere happened outside any strategy theory, and often outside any corporate hierarchy, and sought to directly mobilize consumers in the market by offering them better value, comfort and speed for the price. For the venture caps, BMs brought the computed proof of profitability for their investments.

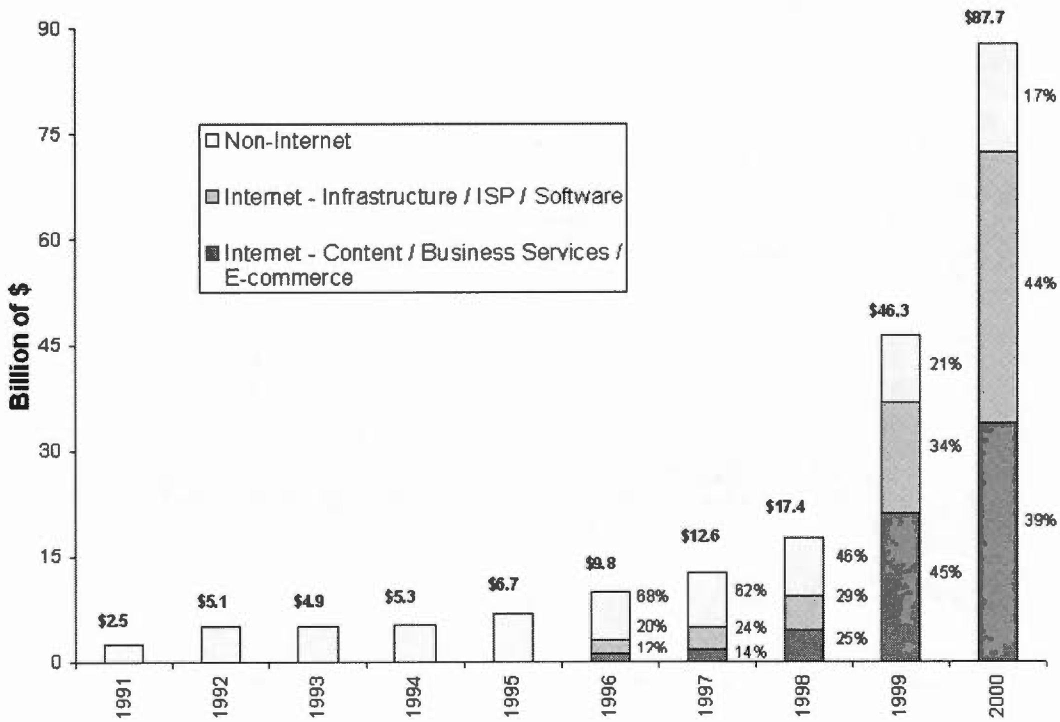

Figure 1.1 Growth and Composition of Venture Capital Investments in Nominal Dollars, 1991-2000

Source: Zook, 2002.

1.2.1 (Digital) Value BM or VBM

The BM concept (Figure 1.2) began to be heavily used in the business world around 1995 when entrepreneurs began designing electronic companies whose economic profits seemed so evident before the Internet bubble of 2000. At the time, BM designers adopted 'thin' design principles and practices.

Keywords and Cultural Change **541**

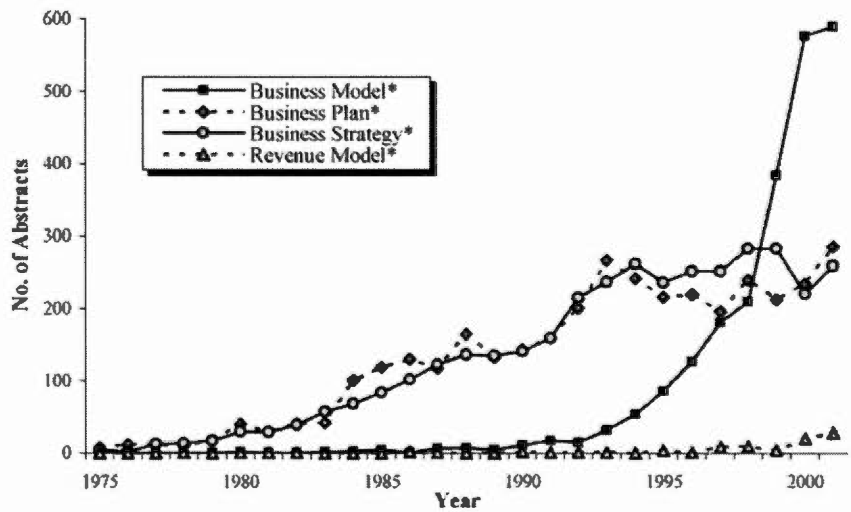

Fig. 1. Incidence of *business model* and related management terms, 1975–2000. *Note*:

Figure 1.2 Incidence of 'Business Model' and Related Management Terms

Source: (Ghaziani & Ventresca, 2005)

Why did BMs become popular around 1995? At the dawn of the age of electronic commerce, the Internet was a new way to connect with the customer through new distribution and interaction channels and/or a new customer interface. Online electronic connections had a lot of advantages over the physical world; that period saw the birth of the 'bits vs. bricks' dilemma.

In the business world, BM reaches a kind of objective status because it is computable: in the end, a BM generates costs and revenues. In fact, BM is mostly a practical—not academic—concept (Eyquem-Renault, 2011); it's more of an explicit recipe than an identity-developing strategy. A BM canvas (BMC) considers the customer interface, offerings, costs and revenues computation and the activity system. BMC developers came from the MIS discipline that developed formal BM ontologies (Osterwalder, 2004). They also wanted to improve design guidelines to help the design process using computer-assisted design (CAD) software. During the dot.com era, from 1995 to 2000, BMs can be understood as being born from a triple encounter between corporate finance, corporate strategy and spreadsheet software. It is a tool to develop a joint understanding by a group of people of a certain BM's underlying assumptions and hypotheses fitting external invariants. Cognitively speaking, a BM is a 'thing' (a mental representation) computed thanks to external invariants—BM canvases are made of key business categories—while subjective invariants promoting the subject role are outside the main BM paradigm. The absence of subjective invariants in BM design hampers the emergence of BM designed for sustainability and strong sustainability.

1.2.2 Architectural BM or ABM

Following Teece (2010: p. 173), a BM, "if it is not a spreadsheet or computer model, might well become embedded in a business plan and in income statements and cash flow projections. But, clearly, the notion refers in the first instance to a conceptual, rather than a financial, model of a business." For Teece (2010), a BM is nothing less than the organizational and financial 'architecture' of a business. Zott and Amit (2010) essentially view a BM as an activity system; they describe it using two sets of parameters, design elements and design themes: "we suggest two sets of parameters that activity systems designers need to consider: design elements—content, structure and governance—that describe the architecture of an activity system; and design themes—novelty, lock-in, complementarities and efficiency—that describe the sources of the activity system's value creation" (Zott & Amit, 2010). Zott and Amit (2008) also posit that a business model, while often regarded as a paradox in business literature (Klang et al., 2014), is the modern complement of strategy formulation in business ecosystems and, in some way, a substitute for organizational structure. A BM's unit of analysis is bound only by the vast business ecosystem out of which it is emerging.

The post dot.com boom era after 2000 is a period where various architectural views of IT applications, networks and data became synthetized into an 'enterprise architecture' approach sold as a new buzzword to executive managers in various books with titles like 'Architecture as Strategy' (Ross et al., 2006). Lastly, authors tried to put forward the idea of a 'foundation for execution,' a mix of processes, data, technologies and consumer segments fitting a 'model for execution,' belonging to the business model concept.

The idea of 'architectural BM' opens the BM concept to platform design (Tirole, 2016), as successfully mastered by large technological firms. It also opens the BM concept to specific architectural patterns like that of the circular economy.

1.2.3 Sustainable BM or SBM

Year after year, the natural environment finds its way into the business landscape by questioning existing BMs. Bansal and Hoffman (2012) present a history (Figure 1.3) of this integration as coming in three waves: regulatory compliance (1970), strategic environmentalism (1990) and sustainability (2010). This progression of the natural environment concept in corporate headquarters has a practical underpinning: since the year 2000, sustainability has become the ultimate competitive advantage (Nidumolu and al., 2009). Because customers are inclined toward ecology transparency and a consciousness of the physical limits of the planet, "[in] the future, only companies that make sustainability a goal will achieve competitive advantage. That means rethinking business models as well as products, technologies, and processes" (Nidumolu and al., 2009: p. 1).

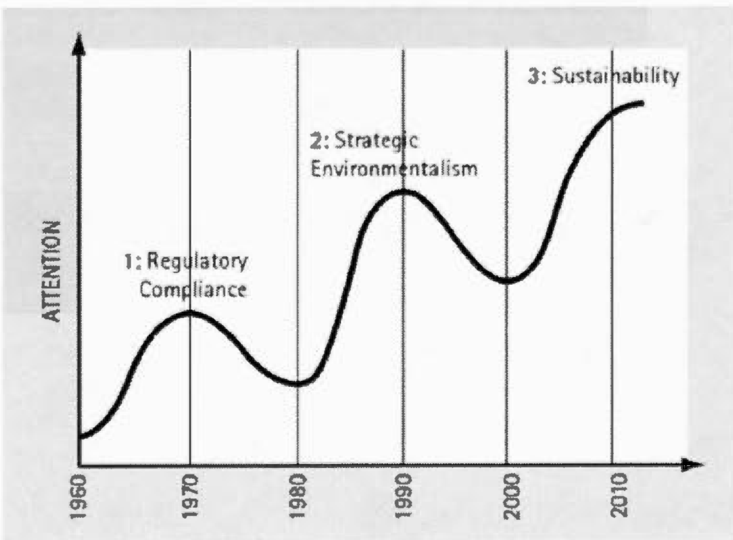

Figure 1.3 The Three Waves of Corporate Environmentalism, 1960-2010

Source: Bansal and Hoffman (2012)

In fact, since 2009, year after year, joint surveys by BCG and MIT show sustainability progression inside corporate decision-making processes (Figure 1.4). Therefore, a business model for sustainability is "the blueprint of a company's business logic which internalizes the business case for sustainability" (Lüdeke-Freund, 2009, p. III), where the aim is to have a "lower environmental impact than traditional business models" (Johannsdottir, 2014: p. 42).

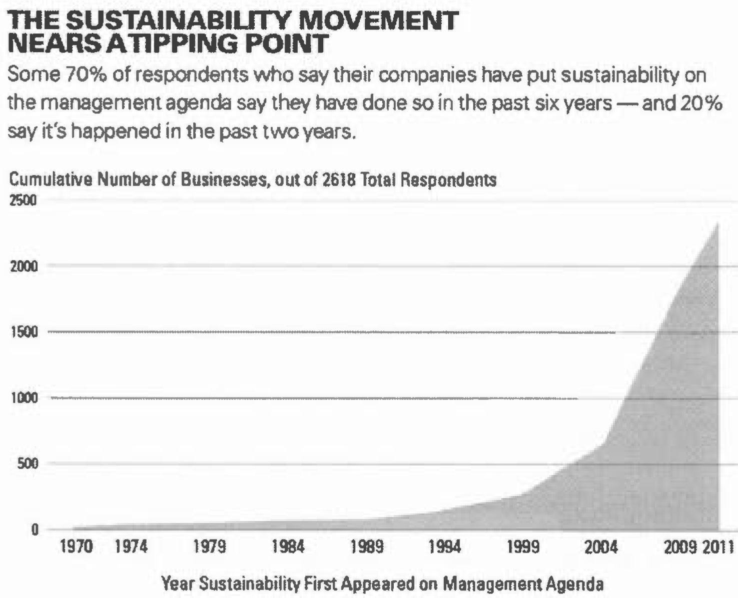

Figure 1.4 The Sustainability Movement Nears a Tipping Point

Source: Kiron, D. 2012: p. 69

The quest for strong sustainability equates with the quest for a 'flourishing' business future (Laszlo and Sorum Brown, 2014), as stated by Ehrenfeld (2008) in his 'flourishing' manifesto. Ehrenfeld[11] wrote on his blog: "Those who follow me know I am backing off from using the word 'sustainability' because it has become merely a jargon word with little or no meaning or a euphemism for continuing to do the same thing as before with perhaps some slight improvement." In fact, if we listen well, we hear that jargon everywhere. For example, in the automotive industry where Ecoboost, Eco efficiency, Partial Zero Emission, Earth Power, Sky Active etc. describe engines that burn carbon-based fuels that will produce the greater part of greenhouse gas emissions; the Jetta TDI being an extreme example of pollution generation, deception and illegal manipulation.

Conversely, a BMF (a BM for a flourishing future) requires the presence of conditions for situated cognition and macrocognition that are missing from traditional BMs. According to Huebner (2013), macrocognition[12] or group cognition requires three preconditions to be a real living phenomenon:

- Principle 1: Do not posit collective mentality where collective behavior results from an organizational structure set up to achieve the goals or realize the intentions of a few powerful and/or intelligent people. (p. 21)
- Principle 2: Do not posit collective mental states or processes where collective behavior bubbles up from simple rules governing the behavior of individuals; intentional states, decisions, or purposes cannot legitimately be ascribed to such collectivities. (p. 23)

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[11] John R. Ehrenfeld is Executive Director of the International Society for Industrial Ecology. He retired in 2000 as the Director of the MIT Technology, Business, and Environment Program, an interdisciplinary educational, research, and policy program.

[12] "That is, if the intentional stance produces useful explanations and prediction of group behavior, it is because there is a certain cognitive structure in place, and we need a story about that structure in order to move from the explanatory practice described in intentional stance theory to a cognitive science of group minds. To address this need, Huebner couples the intentional stance with a theory of cognitive architecture. In so doing he provides not only a compelling account of macrocognition (group cognition), but also a compelling picture of how intentional systems theory can be wedded to a cognitive science of the mind." (Website http://ndpr.nd.edu/news/47449-macrocognition-a-theory-of-distributed-minds-and-collective-intentionality/, visited on December 2, 2014.)

- Principle 3: Do not posit collective mental states where the capacities of the components belong to the same intentional kind as the capacity that is being ascribed to the collectivity and where the collective computations are no more sophisticated than the computations that are carried out by the individuals who compose the collectivity. (p. 72)

Corporate BM design and transformation relate to the power of a few influential and/or intelligent people, like senior executives, international consultants, and brilliant academics. The strategic drive created by an efficient BM fits a business hierarchy (Figure 1.5).

A FRAMEWORK FOR ANALYZING BUSINESS MODELS

In our survey, when respondents answered questions about sustainability and their business models, we presented them with a business model framework developed by the Boston Consulting Group. This framework describes business models in terms of a value proposition and an operating model.

VALUE PROPOSITION: What are we offering to whom?	OPERATING MODEL: How do we profitably deliver the offering?
TARGET SEGMENTS: Which customers do we choose to serve? Which of their needs do we seek to address?	**VALUE CHAIN:** How are we configured to deliver on customer demand? What do we do in-house? What do we outsource?
PRODUCT OR SERVICE OFFERING: What are we offering customers to satisfy their needs?	**COST MODEL:** How do we configure our assets to deliver on our value proposition profitably?
REVENUE MODEL: How are we compensated for our offering?	**ORGANIZATIONAL CHANGE:** How do we deploy and develop our people to sustain and enhance our competitive advantage?

Figure 1.5 BCG Framework for Analyzing Business Models

Source: Kiron, D. et al. (2013: p. 70)

This thesis' stance is that traditional BMs belong to the computation/interpretation paradigm but the design and implementation of a BM for flourishing future (BMF) should require more than computation as cognitive processes and should include situated cognition and macrocognition. Our research angle is the following: a BMF—like a BM—is a cognitive artefact. But as a BM is developed under a more traditional computational-interpretative cognitive view, a BMF asks for new preconditions, namely situated cognition and macrocognition. In this way, actors design a BMF through their sensorimotor interface to socio- and physical materiality where meaning emerges from multiple interactions. Also, a BMF becomes a shared public object open to social competence development in a situation where macrocognition principles apply.

More precisely, the introduction of the natural environment into day-to-day business language cannot be equated with the introduction of the word 'sustainability,' a notion that has had a complex and ambiguous meaning since the Brundtland Commission in 1987, unifying the social, economic and natural environments. After Jouvenel (1957), Boulding (1966), Georgescu-Roegen (1971, 1977, 2002) and Passet (1979, 2011), in 1987, the Brundtland report defined sustainable development as: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." But the introduction of the natural environment offers some traction for a better utilization of the 'sustainability' concept. In fact, the firms have the choice to invest in a defensive way to conform to the rules and the laws that protect the natural environment (Regulatory Compliance era) or to start to innovate with sustainability in mind to develop and offer new products, new processes and new business models, thereby creating or transforming organizations and business ecosystems (Sustainability era). This thesis focuses on this latter type of business models for a flourishing future (BMF).

A business model can be described as the blueprint of a firm's business logic (Lüdeke-Freund, 2009a) and explains the rationale of how companies create, deliver and capture value (Osterwalder & Pigneur, 2009). The key focus is on the firm and its exchange partners, in terms of illustrating the link between the firm and "the larger production and consumption system in which it operates" (Boons et al., 2013: p. 1; Lüdeke-Freund, 2009). Clearly the BMF concept is still debated as a functional concept (Engeström & Sannino, 2012) because BMs in themselves are multifaceted and because sustainability opposes weak sustainability tenants to strong sustainability defenders and, finally, to 'flourishing' BM explorers. BMFs are still under debate, particularly when researchers oppose classical market techno-materiality (carbon market), socio-materiality (activity system) and physical materiality (physical environment, such as carbon cycles). Does 'end of pipe' regulation really equate to sustainability promotion? And do carbon markets equate to a sustainable initiative? It depends on one's definition of sustainability and on one's position as a stakeholder in the sustainability debate: polluter vs. environmentalist, citizen vs. regulator etc.

As mentioned by Engeström and Sannino (2012: p. 201):

> In traditional studies of concept formation and conceptual change, the focus is usually on well-defined and stable concepts of natural sciences and mathematics. This is the domain of "formal concepts," as Greeno (this issue) calls them in his commentary. On the other hand, news media, political debates, and problem solving in work activities are saturated with different concepts. Again following Greeno (this issue), we may call them "functional concepts." These concepts are inherently polyvalent, debated, incomplete, and often "loose" (Löwy, 1992). /…/ Functional concepts are loaded with affects, hopes, fears, values, and collective intentions.

There are many perils to brave to transform a formal concept, the BM, into a functional concept loaded with beliefs, emotions and subjective invariants. Are BMFs by nature condemned to never-ending negotiations that fall short of formal concept status?

Maybe the world's best-known BM is the razor-blades BM in which a company charges the customer much more for the blades and gives away the razor in a bid to make more money with recurrent transactions. This is a pattern. It can be applied in different industries like computer printers. In their BM book, by analogy, Osterwalder and Pigneur (2010) propose the five following patterns: 1. Unbundling business models, 2. The long tail, 3. Multi-sided platforms, 4. 'Free' as a business model, and 5. Open business models.

But, again, the BM concept has many limitations. Roos (2014: p. 248) exposes the theoretical limits of BMs:

- The first concern is the unresolved overlap of the business model idea with established concepts, levels of analysis, theories, etc.
- The second concern is a lack of independence of the concept from other levels of analysis. The business model concept is a concept that varies depending on the firm, the industry or the nation in which it is being employed as well as varying over time.
- The third concern relates to whether a business model can define a unique (and informative) level of analysis.
- The fourth concern is the lack of any consistent definition of the term "business model." The current variation in definitions appears too wide (e.g., includes contradictory statements). Without some level of consensus regarding the idea and its drivers and boundaries, it is difficult to make headway on its theoretical value.
- The fifth concern is a lack of solid empirical support thus far. This does not mean that there is none just that the complexity of isolating and linking it causally is hampered by the second and fourth concern above.

1.3 Conclusion

If our understanding of the evolution of the BM concept over time is sound, and as BMs are "things in our head", we can derive the following presuppositions:

1. BMs for digital value are associated with computing as a cognitive mode, and as the computation is done inside a business hierarchy, essentially about 'what if?' questions related to fixed categories, this computation aims at becoming a strategic driver for investors, shareholders and managers.

2. Architectural BMs don't imply spreadsheet use but a visualization process leading to the discovery of new organizational capabilities supported by new platform capabilities in an emerging way. The digital economy transforms extant value chains (Tirole, 2016) and stimulates exchanges between communities of users while bringing assistance in an attention economy; this gives birth to new configurations like the economy of sharing (Cohen & Kietzmann, 2014; Cusumano, 2014) and the circular economy (Haas et al., 2016; Ning, 2001). BMs become strategic drivers not only for investors, shareholders and managers but also for user communities and actors in the supply chain. These BMs are still designed inside a hierarchy, but designers are developing new bonds with different user communities in an interpretative mode from a cognition standpoint.

3. BMFs, BMs for flourishing future, represents a turning point in a family of more or less sustainable BMs. BMF designers, following Ehrenfeld (2005, 2008), chose to cut their design program off from hierarchical constraints and pressures to focus on life on earth. This is a radically new program for business hierarchies whose managers and members should change their cognitive mode toward new cognitive modes like situated cognition and macrocognition, thereby attracting citizens and customers.

This description of BM evolution is an interpretation that has some limits. There are no fixed dates to the three periods that, at times, overlap. However, nobody can deny the message sent by the Internet bubble of 2000, which marked the end of too simplistic BMs. If macrocognition cannot happen inside a hierarchy (Huebner, 2013), there are a lot of 'network-like' organizational forms between market and hierarchy (Thorelli, 1986; Lamoreaux et al., 2002). But, there is no theory about macrocognition inside those various forms.

CHAPTER II

A JOURNEY INTO ACTION RESEARCH AND DESIGN SCIENCE

2.1 Introduction

Checkland (1985) introduced framework F definition as a key first step in action research (AR) while composing his SSM (Soft Systems Methodology). This chapter defines the FAC framework F where VBM, then ABM and BMS/BMF design challenges are discussed. The notion of cognitive artefact is presented; this notion is the essential part of our framework. As cognitive artefacts, we position BM/BMS/BMF design in a 3D framework using Flourishing, Artificiality and Cognition axes. After discussing the FAC conceptual framework, this chapter continues with practical and research problem definition followed by research propositions, questions and goals. Per Checkland (1985), M declares the methodology to apply F to A. M, in this thesis, as a methodological approach, is a mix of action research and design science. AR is the guide to apply F in A under M; design science (DS) is the guide to bring the lessons learned a step forward into the definition of an artefact's specifications. Following Figure 2.1, A, per Checkland (1985), designs the area of application where F is applied under M. In this thesis, there are two As: a teaching experiment with EMBA students and a table game specifically developed for managers working in the sustainable development unit (SDU) of a large Canadian city. Chapters three and four will be dedicated to these two practical experiences. Results of learning about F (framework), M (methodology for applying F) and A (area of application) through M (mainly action research and design science) are described in chapters five, six and seven and oriented by the goal of specifying an intelligent mobile gaming environment.

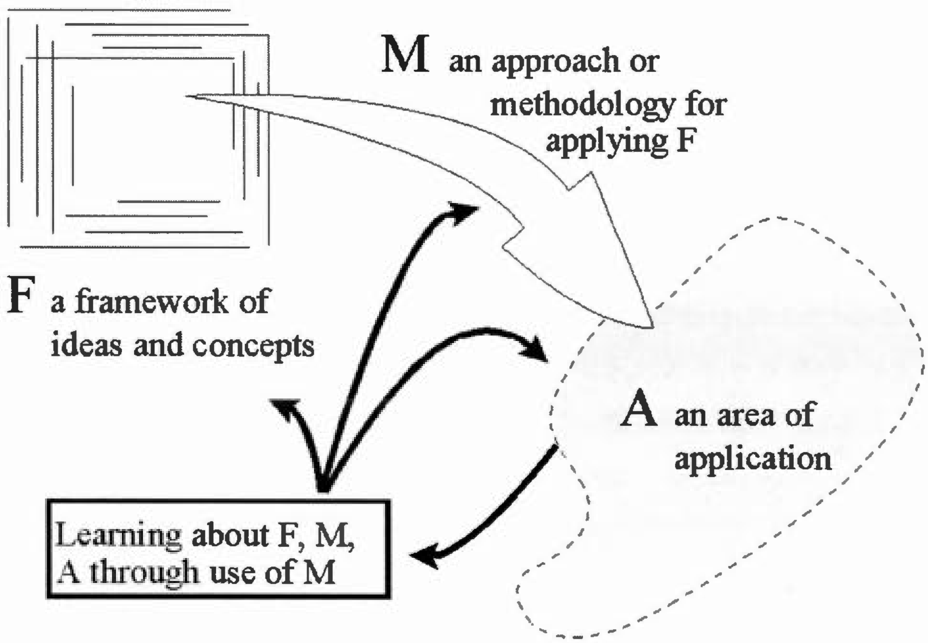

Figure 2.1 Action Research Approach following Checkland (1985), Baskerville & Wood-Harper (2016)

2.2 Problem Statement

2.2.1 Practical Problem(s)

A practical problem is how to enable EMBA students—who are holding managerial positions—to make room for macrocognition, abduction and knowledge use in order to "get there!," meaning to make their business case reach a flourishing state. This research being exploratory and limited in replicability, we won't explicitly mention other practical problems like the formulation of corporate 'green' strategies and their implementation. However, we had the opportunity to work with the SD unit of a large Canadian city.

How must the BM/BMF be positioned on the artificiality trajectory, and how can it be navigated back and forth with fluidity? How is it possible to reach a thought that is effective and complex enough to encompass physical materiality, organization and people? Classical BM design's sole successful approach (more than 1 million books sold) is the BMC gamification (Gray, D. et al. 2010) approach proposed by Osterwalder and Pigneur (2010). It is very tempting for a professor to use a proven recipe. But is a BMC recipe adequate for BMF design? Or, in essence, is a BMF simply a BM extension or another game?

A priori, BM gamification is not suited for BMF design (Table 2.1). Management training is expected to turn more radically toward sustainability as evidenced by the special issue of *Academy of Management Learning & Education,* which is entirely about sustainability *(Special Issue: Sustainability in Management Education).* In this issue, Haugh and Talwar (2010) examine the definition of sustainability and its three pillars: economic, social and environmental. For the authors, the learning of sustainability is based on a wide range of tools and techniques: codes of conduct, outcome measures, policies and structure of the company, purchasing initiatives and supply chain, communications and dialogue, employee training and workshops, visits to companies and volunteer opportunities for employees.

For Benn and Martin (2010), management training relies too much on propositional knowledge and not enough on experiential knowledge, presentation and practices. To begin with, Shrivastava (2010) emphasizes the passion and commitment to sustainability over any other technical approach.

Table 2.1 *A Priori* Distinction between BM and BMF Design

	BM DESIGN	**BMF DESIGN**
BMI Strategy	Mapping: ontologies, frameworks or	Experimenting, Effectuation, Leading Change
Mindset	'All united for profit'	Contradictory discourses
Concept	Practical	Functional
Design scale	Enterprise BM	Business ecosystem BMS
Artefact level		
	Products offering	Products offering
	Services offering	Services offering
	Customer interface	Customer interface
	Nil	Social network
	Nil	Social project
	Nil	Solidarity discourse
Disciplines	"Thin" approaches with IS, marketing, economics	"Thick" approaches with ecology, systems dynamics, organizational architecture,
Learning mode	Analytic	Descriptive
Cognitive mode	Computation/Interpretation	Interpretation/Situated cognition/Macrocognition/ Computation
Logical mode	Induction/Deduction	Abduction/Induction /Deduction

Benn and Martin (2010) emphasize learning sustainability in the context of local ecosystems, where there is proximity to a university and the social, economic and ecological spheres. Communities of practice can promote this type of learning. To Wu and al. (2010), there is a sharp contrast between what should be taught about sustainability and the bias of business schools that teach that all that matters is profitability and shareholder value, the latter serving as a backdrop. Instead, the concept of sustainable development is the result of a growing awareness of global links between growing environmental problems, socio-economic issues related to poverty and inequality and the concern for a healthy future for humanity. For example, *MIS Quarterly* inaugurated the field of *Energy Informatics* in 2010, a field that examines ways to improve energy efficiency and sustainability. Hart (quoted in 2012) mentioned that BMS design and implementation is a matter of organizational design and will.

Examples of this abound. Pinnacle West (PW), an energy provider in Arizona (US), still produces electrical power mainly from nuclear plants and coal- and gas-burning installations. Since 2013, what has changed radically in the field of sustainability at PW is the structure and content of annual reports and some business practices. PW is perhaps compensating its GES emissions through the carbon market. Sources of solar energy are being developed while sustainability and innovative culture are now key ingredients with GRI[13] reporting. In summary, PW's basic BM has not changed, but it is now wrapped in a greener discourse. The question of 'will' or 'getting there' is the first step in a BMF design experiment. Daily observations, social networks, TV channels and newspapers demonstrate the 'green facade' strategy (without will to change)—one of the most dramatic examples being the Volkswagen (VW) group—

[13] Initiatives undertaken by environmental activists and committed decision-makers led to the creation of the GRI (Global Reporting Initiative), non-profit organization based in Amsterdam in 1997, by CERES, an NGO based in Boston and key player in the integration of environmental issues into business operations.

still comes first on the Dow Jones Sustainability Index in 2013 while selling heavy polluting vehicles in the US and Canada (VW Jetta TDI). Nidumolu et al. (2009) argue that the next 'green' practices sharing platform should question the dominant logic behind business today through the sustainability lens.

Conversely, in Germany, where another type of sustainability landscape is emerging Jacobsson and Lauber (2006), there is another situation for a similar player in the same industry. Werner Wenning, chairman of the German utility group E.ON Supervisory Board, described the new strategic options endorsed on Sunday, November 30, 2014, in Düsseldorf. In fact, the proposed measures are radical and have no equivalent in Europe. E.ON eventually plans to abandon its conventional electricity production to focus on renewable energy, such as wind and solar. To show the importance of this decision, it is as if, in France, EDF moved away from its nuclear plants and embraced wind power and photovoltaic energy. The German group also confirmed several divestitures and announced significant write-downs. "*The model of a wide range of activities does not correspond to the new challenges*," said Johannes Teyssen, CEO of E.ON. "*We want to reposition ourselves radically*"[14]. Pinnacle West may enhance its processes, security, added value etc. always in the same (very) weak sustainability paradigm. Conversely, Werner Wenning wants to develop a more radical BMF

This is a practical managerial and strategic problem: how to innovate and how to transform a traditional BM into a BMF? How to train students and managers so they understand and apply weak, strong sustainability and flourishing distinctions? But:

> To solve your practical problem, you first have to think up a relevant research problem about the topic and then solve that research problem. Learning the

[14] (Le Monde, December 1st, 2014—Our translation)

> answer to the research problem will let you understand how to resolve the practical problem.[15]

The practical problem for managers and students is to design and implement a BMF, with strong sustainability in mind:

> A practical problem happens in the real world. It costs you something in time, money, happiness, etc. You'll solve that problem by doing something to change something out there in the real world. A research problem, on the other hand, starts in your mind when you don't understand something. (idem)

Practically, this thesis' hypothesis is that typical BM design through gamification doesn't fit BMF design requirements because BM gamification is conceived without macrocognition/situated cognition, without fluid navigation on artificiality axis and in a context limited to techno-materiality.

2.2.2 Research Problem

Sustainability is still a debated 'functional' concept (Engeström & Sannino, 2012) interacting with computational BMs induced by GRI reporting practices. There isn't an easy way to create a BMF design because sustainability is about science and physical materiality while BM is a (non-scientific) practical value creation/capture pattern (made to stay as it is conceived) based on a combination of market immateriality and activity system socio-materiality.

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[15] Source: The Research Question; website http://www2.uncp.edu/home/acurtis/Courses/ResourcesForCourses/HowToResearch/ResearchQuestion.html, visited December 2, 2014.

Consequently, this thesis considers BMF design from a cognitive science perspective. It considers the cognitive science angle because BM and BMF literature is constantly sprinkled with words, concepts or categories like beliefs, representation, subjectivity, knowledge types and cognitive processes (such as understanding, learning or creating), ontology and formal ontologies, words and terms that come from cognitive activities. We also take a cognitive science point of view because MIT Sloan and Boston Consulting Group identified two cognitive barriers to sustainable BM design and use (2009): 1. lack of understanding of sustainability, and 2. lack of capabilities to design strongly sustainable business models. The sustainability-flourishing challenge is first a matter of cognition, both individual and organizational. 'Understanding,' with 'Remembering,' are referred to by Anderson and al. (2001) as the fundamental cognitive process while, at the other end of its taxonomy progression, 'Creating' sits at the top of the cognitive processes (Figure 2.9). It can be hypothesized that the whole range of cognitive processes and knowledge types are questioned by the introduction of sustainability in BMs. The research problem is thus formulated using learning theories established by Anderson et al. (2001), Kolb and Kolb (2005) and Beckman and Barry (2007).

Learning is the process whereby knowledge is created through the transformation of experience. In 1984, Kolb drew from these numerous theories of learning to build what he called "experiential learning theory" in which he defined learning as "the process whereby knowledge is created through the transformation of experience," and he defined the learning process as applying the four steps of experiencing, reflecting, thinking and acting in a highly iterative fashion (Beckman & Barry, 2007: p. 28).

If learning is "the process whereby knowledge is created through the transformation of experience," we need to understand in the real world how MBA students or managers understand flourishing requirements in BMF case solving and how they deal with them. We also need to understand how sustainability managers in a big city integrate BM notions into their thinking while designing sustainable development plans.

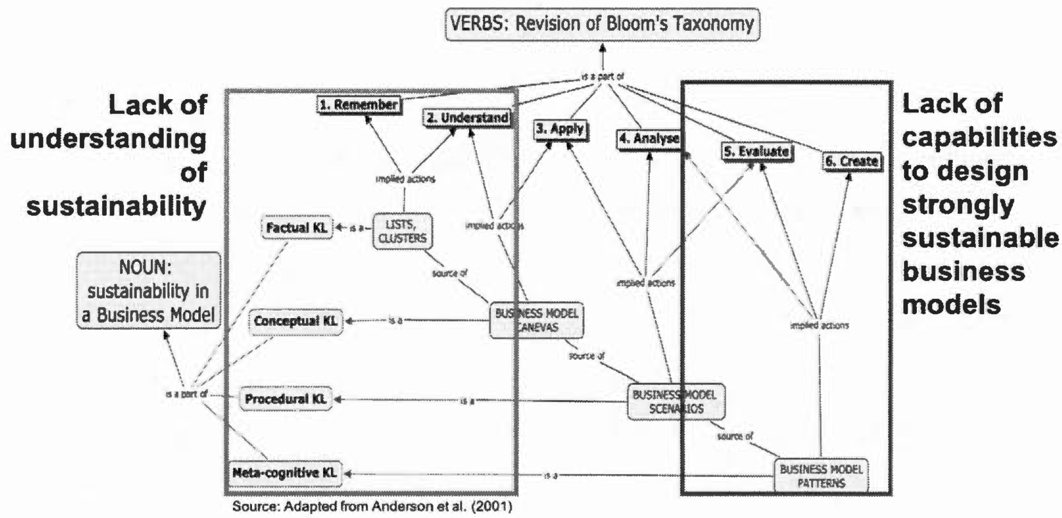

Figure 2.2 Illustration of Lack of Understanding and Lack of Capabilities to Design Sustainable BMs

Source: Adapted from Anderson et al., 2001.

Learning theory shows many differences between the traditional cognitive approach and situated learning. For example, the locus of learning is conventionally positioned in the mind of the learner as an individual phenomenon. On the contrary, in a situated learning approach, a learning phenomenon is situated in a relationship between person(s), activities, education and professional practices. Elsbach *et al.* (2005) and Ciborra & Willcocks (2006) systematize this paradigm in the context of organizational cognition. Thus, the cognitive processes that make sense are rooted in interactions between cognitive patterns and organizational contexts to form momentary situated cognitions. These cognitions can consist of attraction to an option, the perception of a separate self, problem understanding and collective state of mind (macrocognition).

2.3. FAC Framework

Usually, literature in sustainable BMs will consider the traditional formal BM concept as a compuTable core with an interpreTable activity system at the periphery or a compuTable VBM at core and an interpreTable ABM at periphery. However, BMS comes with some sustainability requirements borrowing elements from weak and/or strong sustainability. Those requirements are partly outside computing and interpreting as cognitive modes. This thesis' framework contribution is to integrate the cognitive dimension while positioning BMs (VBMs and ABMs) vs BMSs/BMFs. As a mix of finance, strategy and information technology, BMs are first designed for computing value creation and capture. On the contrary, BMFs are still functional concepts (Engeström & Sannino, 2012) having a subjective meaning for different people and an intersubjective meaning for different groups (possibility of macrocognition). This thesis thus posits three challenging design choices (Figure 2.3):

1. The types of materiality (flourishing axis),
2. The artificiality of designed objects (artificiality trajectory axis),
3. The designer's or designers' cognitive modes (cognition axis).

2.3.1 Business Models as Cognitive Artefacts

Per Paavola & Hakkarainen (2005), "we are working in complex and heterogeneous networks that consist of humans and various artifacts (Latour 1999). To facilitate our more sophisticated activity, we are creating and using cognitive artifacts that are more knowledge-laden, smart and autonomous" (p. 536. Quoting Bereiter), Paavola & Hakkarainen (2005) underline that individual learning—as an accumulation of ready-made information to the human mind—must be replaced by collective learning, a learning activity "akin to what happens in scientific communities, where the central aim is not only to learn something but to collaboratively develop new ideas, methods, theories, models, and so on, that then become available for subsequent use" (pp. 542-543). Paavola & Hakkarainen (2005) call this collaborative activity *artifact creation metaphor of learning,* where "artifacts are object-like things that are produced by humans, and the models of innovative knowledge communities concentrate on processes where people collaboratively create and develop such conceptual and material artifacts and related practices for a subsequent use" (p. 546). And finally: "Characteristic of all models of knowledge creation is that the agent of knowledge creation is not an isolated individual but is either an individual embedded in a community or the community itself (p. 551)."

The Cognition axis in our FAC framework takes this into account by making distinctions between a computed 'objective' BM as cognitive artefact vs. a collaborative BMF based on subjective wills. Per Doz and Kosonen (2010), a BM is objectively about relationships between a firm and its customers, suppliers, complementors, partners and other stakeholders among its internal units and departments (functions, staff, operating units, etc.). In a way, a BM helps instantiate an organizational architecture (OA) inside a business ecosystem. A BM will transform an OA into a desired pattern of patterns by homogenizing both cultural and business rule invariants.

Figure 2.3 shows a progression of BMs, BMSs and BMFs as cognitive artefacts, a progression that can be paralleled with cognitive science evolution from individual computation to macrocognition.

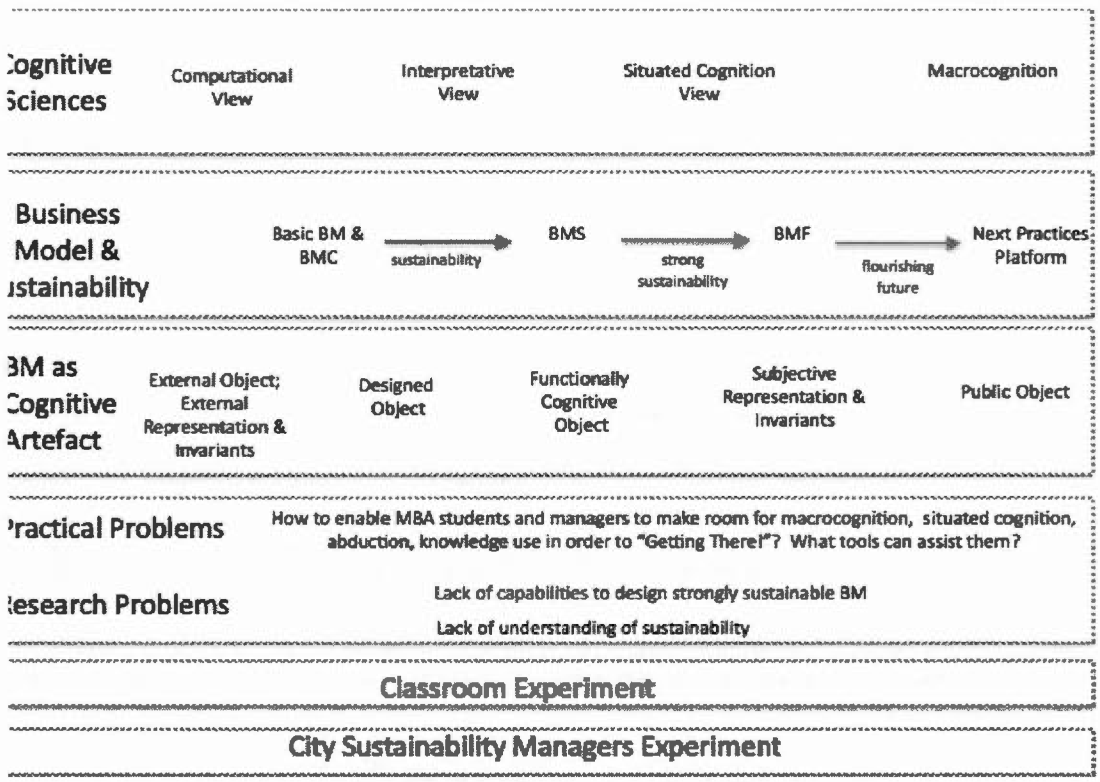

Figure 2.3 BMs, BMSs and BMFs as Cognitive Artefacts

> Business models can be defined both objectively and subjectively. Objectively they are sets of structured and interdependent operational relationships between a firm and its customers, suppliers, complementors, partners and other stakeholders, and among its internal units and departments (functions, staff, operating units, etc). These 'actual' relationships are articulated in procedures or contracts and embedded in (often) tacit action routines. But, for the firm's management, business models also function as a subjective representation of these mechanisms, delineating how it believes the firm relates to its

> environment. So business models stand as cognitive structures providing a theory of how to set boundaries to the firm, of how to create value, and how to organise its internal structure and governance. Both as objective relationships, based on contracts and organizing routines, and as their collective cognitive representation, business models tend also to be naturally stable, and hard to change. (Doz & Kosonen, 2010: p. 370-371).

In other words, BMs are cognitive artefacts (Figure 2.3) composed of both external representations and external algorithms (or procedures) designed (and selected by cultural evolution) for their ability to induce specific provisions in humans using them. The resulting pattern tends to be stable and hard to change because a BM type dynamically connects all organizational domains at different scales to produce a pattern of patterns, meaning a repeatable stable behavior as mentioned by Morabito et al. (1999).

A typical BM is mainly described through its external invariants. By applying a BM to a competitive situation, a manager, by developing his situation awareness to sense or seize an opportunity, cognitively applies a set of invariants external to himself, such as the razor-blades theme, and, using the popular Osterwalder-Pigneur BM canvas (2010), nine categories describing a BM. Doing so, he or she combines Situation Awareness external coupling invariants about subject/environment concepts developed from the affordances of environmental psychology. Its principal purpose is not so much the situation than the interaction scenario (Chalandon, 2013; Gibson, 1979, 2014). But literature in strategic management rarely deals with BM design (Zott & Amit, 2010) and is short on internal invariants, specific to the person. In ergonomic psychology terms:

> 'View of the subject' identifies the Situation Awareness to functional representation whose construction refers to a criterion of pragmatic relevance.

By partial anticipation of the context and pre-activation of internal invariants, the Situation Awareness promotes the inclusion of activity in the dynamics of the environment (Chalandon, 2013).

Concerning the use of BMC, particularly if computerized in a package with assisted design rules, any college student can manipulate coloured objects as coloured *Post-it* notes in a 'design stance,' but organizational architects—to borrow from Dennett (quoted below)—must adopt a 'physical stance' to figure out what sort of design revisions might enhance organizational quality (Figure 2.8).

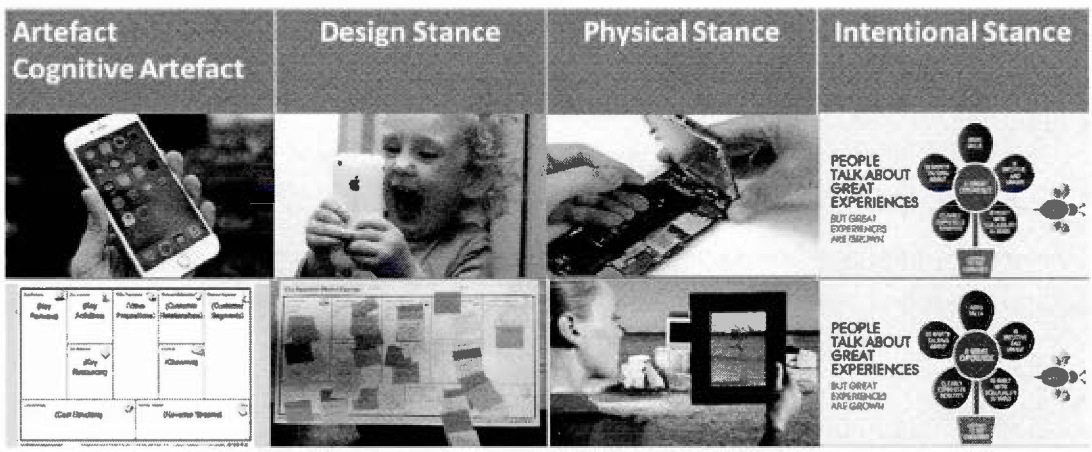

Figure 2.4 Illustration of Three Stances (from Dennett) Considering an Artefact (iPhone) and a Cognitive Artefact (BMC)

If you know something about the design of an artefact, you can predict its behavior without worrying yourself about the underlying physics of its parts. Even small children can readily learn to manipulate such complicated objects as VCRs without having a clue as to how they work; they know just what will happen when they press a sequence of buttons, because they know what is designed to happen. They are operating from what I call the design stance. The VCR repairer knows a great deal more about the design of the VCR, and knows, roughly, how all the interior parts interact to produce both proper functioning and pathological functioning, but may also be quite oblivious of the underlying physics of the processes. Only the designers of the VCR had to understand the physics; they are the ones who must descend to what I call the physical stance in order to figure out what sorts of design revisions might enhance picture quality, or diminish wear and tear on the tape, or reduce the

> electricity consumption of the product. But when they engage in reverse engineering—of some other manufacturer's VCR, for instance—they avail themselves not only of physical stance, but also of what I call the intentional stance—they try to figure out what the designers had in mind. (Dennett, 1995: p. 229-230)

It is our preconception that there is a correspondence between Dennett's stances story and the FAC framework. Techno-materiality paves the way to the design stance. Traditional BM design using BMC implies fresh ideas and computing capabilities, not a physical stance or deep knowledge of the physical environment. Taking our cue from Dennett again, when we engage in reverse engineering, we try to figure out what the designers had in mind regarding consumers, competitors, stakeholders, enterprises. We can read in the business press headlines like "Tesla believes…" or "VW sees…":

> Our attributions of intentionality to organizations are made with only a vague idea of the inner processes of the organization and often without any information about the intentional states of the members. Yet our explanations of the actions of organizations in terms of their beliefs, intentions, and desires are successful (Tollefsen, 2002).

One of those axes (the Y axis in Figure 2.5) is called the Flourishing axis: it describes a progression from physical and biophysical materiality (ecosystems, living environment, living people, carbon cycles) to socio-materiality (organizations with their activity systems) and finally to techno-materiality (carbon markets, eco-services markets, and standard VBM computable business models).

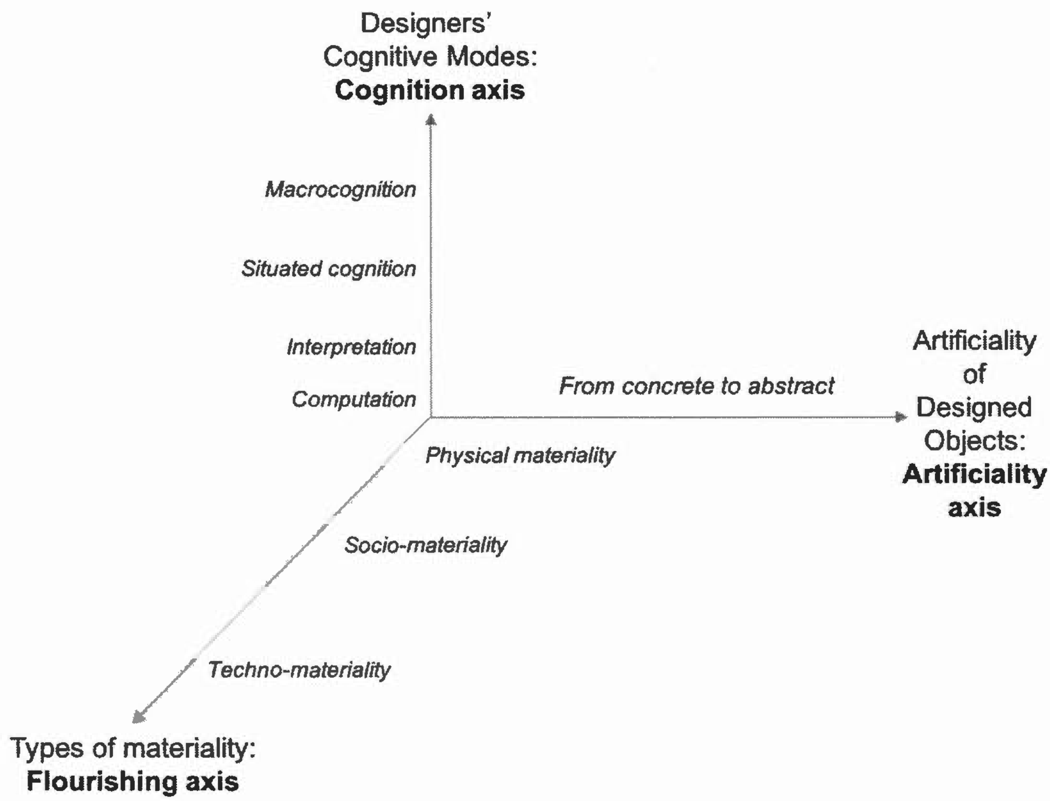

Figure 2.5 The FAC Research Framework (Flourishing – Artificiality – Cognition)

This axis is named 'Flourishing' following Ehrenfeld and Hoffman's (2013) view of sustainability. Artificiality axis proposes a concrete vs. abstract understanding of the artificiality trajectory covering BMs from the product offering (concrete) to the discourses arguing for or against that BM (abstract). Finally, the FAC framework (Flourishing – Artificiality – Cognition) considers four designers' cognitive modes from computation to interpretation, situated cognition and macrocognition.

The 'Artificiality' axis (the X axis) comes from the philosophy of design. Interpreting Krippendorff's (1997, 2007) understanding of design progression from concrete to abstract, it is possible to position a BM's elements along an 'artificiality trajectory' where designers start with a concrete product and end with a project and an abstract discourse, or the reverse. In this thesis, we adapt Krippendorff's trajectory to business design in the following way (Table 2.2).

Table 2.2 Adaptation of Krippendorff's Artificiality Trajectory to the FAC Framework

Artificiality Trajectory Krippendorff (2007): from Concrete to Abstract	Artificiality Trajectory Adapted to Business Design: from Concrete to Abstract
Products	Products
Services	Services
Interfaces, corporate identity	Customer interface, supply chain
Networks	BM as "market device" inside Innovation Networks
Projects	Innovation Projects – Business Model Innovation (BMI)
Discourses	Discourses, BM recipes

Source: Adapted from Krippendorff (2007)

Table 2.2 systematizes a parallel between Krippendorff's artificiality trajectory and its application to BM aspects and dimensions. It mixes elements from BM definition with Krippendorff's artificiality trajectory. Products and services are strictly mirroring each other's frameworks; customer channels and supply chains are the mirroring 'interfaces' category and then comes the BM as the 'market device' inside an innovation network of stakeholders. Costs and revenues are calculated in a computation mode (cognition axis). The Artificiality axis suggests that BMs—and of course BMFs—can be designed or engineered from products and services or retrofitted from discourses and innovation projects. This axis also suggests, as does Simon (1996), that strategic managers committed to BMs, BMIs or change discourses, are designers, like engineers dedicated to product design or marketers to customer interface design.

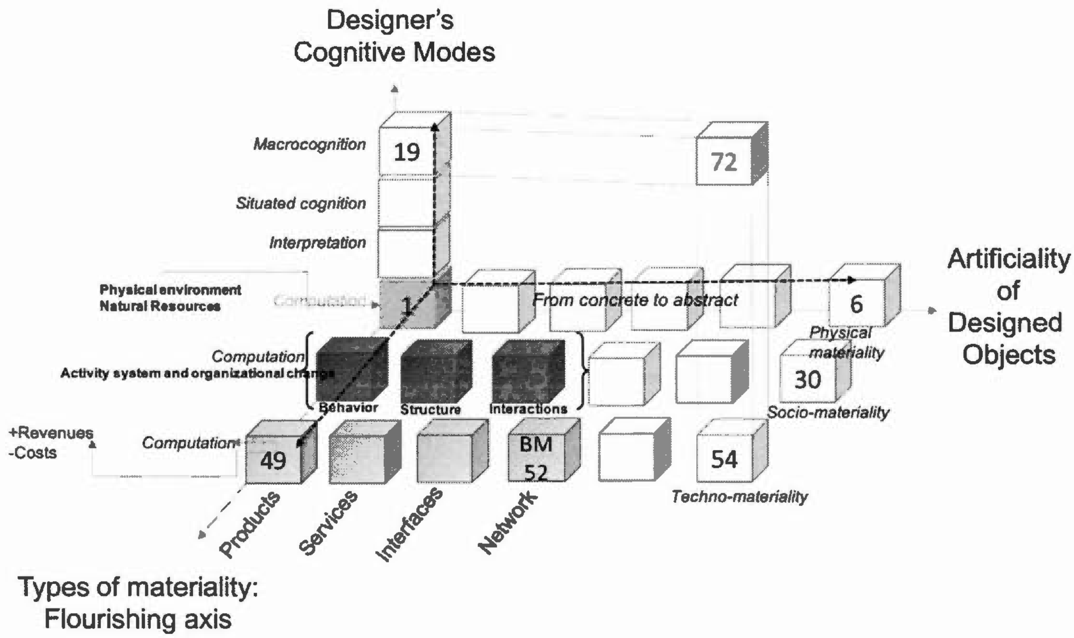

Figure 2.6 From Cube 1: Three Challenges from the Physical Environment

Figure 2.6 displays BM categories for different materiality types. For example, for 'Products,' the 'Products' cube 49 brings data to three dimensions: 1. An artificiality level (the products are concrete elements), 2. a materiality level (at techno-materiality level, products are products' data and metadata) and 3. a cognition level (in this case, a computation level where products' costs and revenues are calculated or life cycle computed). At the artificiality level, the challenge is to produce a coherent discourse and/or a vision and/or a backcasting approach. At the materiality level, the challenge is to produce 'green' products through 'green' processes and 'green' activity systems inside a circular economy. At the cognition level, the challenge is to move forward, beyond computation and interpretation, toward situated cognition and macrocognition as cognitive modes.

'Services' are next to products while 'Interfaces' regroup customer channels and supply chains. The 'organizational change' dimension (Figure 1.4, BCG Framework for Analyzing Business Models), clearly belongs to the socio-materiality level and leads to new interactions between members of organizations inside more lateral structures enabling new organizational behaviors. If some aspects of 'organizational change' can be computed (training costs etc.), its execution calls for interpretation as cognitive mode to evacuate all related ambiguities.

The Cognition axis (the Z Axis: Designers' Cognitive Modes) makes clearer the differences about what is happening cognitively to BM vs. BMF designers: BM designers are measuring and interpreting business logic while BMF designers are adding to that sensing and discussing—individually and/or as a community—what is happening to their 'place' in terms of sustainability and value generation/capture. In fact, BM being mostly a practical concept without any spatial dimension, managers and/or shareholders/stakeholders discuss, design and compute their BMs as they have the legitimacy to act that way. So, one extremity of the cognition axis is assimilated into individual computation inside an organizational hierarchy set up to achieve the goals or realize the intentions of a few powerful and/or intelligent people (Huebner, 2013). By contrast, the other extremity is illustrated by a community of people, living in and inhabiting a 'place,' who meet the conditions of macrocognition (Huebner, 2013). Both powerful people and situated communities are benefitting from technologies enabling cognitive extension (Clark, 2008). Both groups are practicing computation and interpretation as cognitive modes. However, logical modes may differ. The literature shows (Moore, 2007) that, if sustainability management is often a matter of induction/deduction between theory and facts using predefined categories, it is rather formulated and executed in an abductive logical mode in leading 'green' cities. But let's start with VBM design and the examination of the Artificiality Trajectory axis.

2.3.1 Conceptualizing VBMs: Choosing an Artificiality Trajectory in Techno-Materiality Space

VBMs can be entirely discussed on the techno-materiality axis by exploiting Krippendorff's 'artificiality trajectory.' In our view—like in Krippendorff's artefact development view—a BM doesn't start from nowhere, nor is it constructed on solid and stable categories. We see BMs starting as products, services and interfaces and then being formalized into BMs or, inversing the direction on the artificiality axis, starting as a discourse and an innovation project that becomes formalized as a BM. Krippendorff (2007) proposed a trajectory of artificiality "that leads us into new empirical domains and the adoption of appropriate design criteria" (Krippendorff, 2007). As artefacts, products and services are forming what specialists call "*Industrial Product–Service Systems*" (IPS2), which are defined as "an integrated industrial product and service offering that delivers value in use." This field has expanded rapidly over the last decade:

> IPS2 has allowed us to achieve both high added value and high productivity and has enriched our QOL by improving the performance of products and services. We are now struggling with many awkward issues related to sustainability, but IPS2 is expected to be the "Philosopher's Stone" for solving these issues.[16] (Shimomura & Kimita, 2012)

[16] The Philosopher's Stone for Sustainability: Proceedings of the 4th CIRP International Conference on Industrial Product-Service Systems, Tokyo, Japan, November 8th–9th, 2012

Products

"By definition, products are the end products of processes of production, and equating artefacts with products limits product design to industrially manufactured artefacts" (Krippendorff, 2007: p. 19).

Services

> Goods, services, and corporate or individual identities, by contrast, are artefacts that are designed for sales, to have social significance, or to create consumption. Such artefacts are not entirely physical. They constitutively involve individual minds in ways products do not: memories or attitudes favoring particular service providers, for example, or brands. The advent of styling and marketing made the creation of exchange values a priority and a universalist aesthetics had to be abandoned in favor of statistically distributed local preferences. (Krippendorff, 2007: p. 19)

Interfaces

Following (Osterwalder et al., 2005), "Customer Interface" (in this thesis, a substitute term for 'interfaces' on Krippendorff's scale) has three dimensions: 1. "Target Customer" describes the segments of customers to which a company wants to offer value, 2. "Distribution Channel" describes the company's various means of getting in touch with its customers and 3. "Relationship" explains the kind of links a company establishes between itself and its different customer segments. If we transpose Krippendorff's interface context (man/machine) to a business context (customer/firm), we find the same interface semantic understood as interactions.

> As suggested above, interfaces are artefacts that reside between humans and machines including objects of nature. They consist of interactions, rudimentarily resembling human dialogue, not dead matter. Designing interfaces involves criteria that relate users' interactive understanding to what artefacts can afford./.../" (Krippendorff, 2007: p. 19)

Networks

What about an artefact qualified by Krippendorff (2007) as a network surviving "in a medium that many people can access, and their reality depends on the coordinated practices of their users: creating, sharing, storing, modifying, or discarding them"? Is a BM qualifying for 'network' level on the artificiality trajectory?

Doganova and Eyquem-Renault (2009) argue that a business model is a "market device" (Callon et al., 2007) within innovation networks:

> an intermediary between different innovation actors such as companies, financiers, research institutions, etc., i.e., actors who shape innovation networks. In their theory, such networks are created through what they call "narratives" and "calculations" which entrepreneurs circulate to describe their ventures and to construct markets. Here, the business model is seen as a reference point for communication among the different actors with whom entrepreneurs engage. (Boons & Lüdeke-Freund, 2013: p. 10)

Callon (2009) wrote this about networks and carbon markets:

> In concrete terms, such interactions can exist, in the case of markets or any innovation, only if soundly structured networks organize relations between the sites at which in vivo experiments are conducted and those at which in vitro experiments are conducted. Such networks should allow for the joint and coordinated advancement of knowledge and theoretical models on markets, on the one hand, and of market material and institutional devices, on the other. They could provide the organized framework of coordination and information trading between economics and the economy. (Callon, 2009: p. 537)

Muniesa et al. (2007) believe that:

> the notion of 'market device'—a simple way of referring to the material and discursive assemblages that intervene in the construction of markets—can be useful in addressing these concerns. After all, can a market exist without a set of market devices? From analytical techniques to pricing models, from purchase settings to merchandising tools, from trading protocols to aggregate indicators, the topic of market devices includes a wide array of objects. (Muniesa et al., 2007: p. 2)

Resonating with Krippendorff's definition, networks are created through what some authors call "narratives" and "calculations" (Boons & Lüdeke-Freund, 2013); once formalized, these calculations and narratives can become BM artefacts.

> /…/ such artefacts must survive in a medium that many people can access, and their reality depends on the coordinated practices of their users: creating, sharing, storing, modifying, or discarding them, often in view of other users. Trusting and authenticity are the major issues in the use of multiuser systems, which shows their embeddedness in cultural contingencies. (Krippendorff, 2007: p. 19)

Projects

Moving away from BMs, the next stage in the Krippendorff scale is 'projects'; in business terms, these projects are BM innovation projects or BMI in business literature. Chesbrough (2010) offers four ways to overcome cognitive inertia in business model innovation: mapping, experimentation, effectuation and leading change. While 'mapping' is the most exploited dimension in gamification (Osterwalder & Pigneur, 2010), *experimentation* is efficient when "[t]rying out an alternative business model on real customers paying real money in real economic transactions" (Chesbrough, 2010 p.360). Many tools are available to managers wishing to experiment (Davenport, 2009). *Effectuation* is the second set of alternative processes identified by Chesbrough (2010). In this case, there is a strong bias for action over analysis: because there may be insufficient data available to analyse one's way toward a new business model (Chesbrough, 2010: p. 361). Effectuation processes are thus actions "critical for the cognitive act of reframing the dominant logic of one's business model" (p. 361).

Coming back to the Krippendorff scale:

"Projects are primarily social artefacts. They involve people as stakeholders who cooperate in bringing something of joint interest to fruition. To the extent that projects are self-organizing, they are not entirely controllable from the outside". (Krippendorff, 2007: p. 19).

Discourses

Perkmann & Spicer (2010) wrote that "business models are performative in three ways: as narratives that persuade, as typifications that legitimate, and as recipes that instruct." For these authors, BMs are first and foremost narratives:

> Narratives comprise a subject searching for an object, a "destinator" (a force determining the subject's destination), and a set of forces furthering or hindering the subject's quest for a desired object /.../ business model's narratives may be instrumental in inducing expectations among interested constituents about how a business' future might play out. (p. 270)

In the 90s, BMs were narratives used to attract investors to an e-business venture. Following Perkmann & Spicer (2010), a BM "allows a venture to associate itself with a particular type or identity, thereby creating a sense of legitimacy. /.../ firms may attempt to render themselves identifiable and legitimate by associating themselves with certain business models that form known categories" (pp. 270-271).

Finally, a BM:

> provides recipes that instruct actors involved with the business what they should do. Managers are often guided in their decision by cognitive frameworks that privilege certain courses of action to the exclusion of others /.../ They constitute mental models that codify some key causal relationships assumed to underpin "the business" a firm believes to be in. (Perkmann & Spicer, 2010: p. 271)

This introduction to BMs as discourse resonates with Krippendorff's discourses stage definition:

> Naturally, the final kind of artefact in the trajectory is: Discourse, institutionalized communication, a constrained way of languaging. In discourse, particular ways of languaging dominate reality constructions and direct the practices of the members of a discourse community. /.../ Inventing productive metaphors, introducing new vocabularies, and starting to talk differently are ways to direct the social construction of alternative worlds and the artefacts therein. These are fascinating artefacts.

And:

> Design can succeed only if these two conditions are satisfied. A design that is not inspiring is not a viable proposal, and an artefact whose possibilities cannot be recognized has no meaning. The virtual worlds we come to see in artefacts should not be pretended but realizable and virtuous. (p. 21)

Krippendorff (2007) insists on a chasm between the intentions that underlie a design and the effective realization of a design when other intentions emerge:

> The point of these observations is that designers rarely ever produce what they say they are designing. /.../ Designs are rhetorical devices, proposals that, ideally, compel interested stakeholders to act in ways called for by the design. As a proposal, a design must be understood, actionable, realizable in concrete stages, have virtue, and enroll stakeholders to proceed. So conceived, a design is but one—albeit intermediate—form of what a proposed artefact could become. (Krippendorff, 2007: p. 19)

And all those artefacts evolve on moving sands so there is never a 'final' artefact:

> The point is that artefacts are far from stable, as popular conceptions of tangible objects have it. Artefacts change, sometimes within the conceptual categories of their users, often and ultimately into other categories, mostly useless or problematic ones. The underlying dynamics—ineviTable destiny, problematic breakdowns, or unintended consequences—are not addressed when designers focus their attention on designing final artefacts of a certain kind or category. (idem)

2.3.2 Conceptualizing ABMs: Moving from Techno- to Socio-Materiality

ABMs, or architectural business models like circular economy, shared economy, and a variety of activity systems, are better described on the socio-materiality axis. In fact, ABMs are mostly present on the socio-materiality axis (and the techno-materiality axis) because value computing is still the big issue.

The quest for socio-materiality or the materiality-turn is recent:

> Following Latour (Latour, 2007: 139), the materiality-turn is related to the "the way we move knowledge forward in order to access things that are far away or otherwise inaccessible" (materiality) or "the way things move to keep themselves in existence." We propose to call this 'matter-iality,' to emphasise how things matter. Instrumentations, mediations, materializations and performations are at the heart of the materiality- turn, which has strong intersections and commonalities with other turns such as the practice turn, communication turn, visual turn, process turn, performativity turn or spatial turn. (https://en.wikipedia.org/wiki/The_Materiality_Turn, visited on November 15, 2016)

Natural resources coming from the physical environment (cube 1) will be transformed by several activity systems that together form a supply chain to deliver a final product defining (part of) a value offering whose data are located on cube 49 (Figure 2.4). Or, if we move in the other direction (from 49 to 1), cube 49 is a product idea that will be manufactured in the activity system (the Behavior, Structure and Interactions cubes) from resources drawn from cube 1, which features the physical environment. As a convergence of corporate finance and corporate strategy made explicit through a spreadsheet, a BM inherits a tradition of techno-materiality or immateriality. But because matter matters more and more (Carlile, P.R. et al., 2013), socio-materiality is described and theorized as essential to the understanding of organizations. The following chapters will explore the cognition axis, but we can already be conscious that shared economy and circular economy, without being explicitly connected with the future of the physical environment, are asking for more than computation on the cognition axis; they are asking for situated cognition and macrocognition along the socio-materiality axis. In Figure 2.5, cubes 42 and 48 respectively indicate a personal vision and discourse about circular (or shared) economy and a common vision among individuals about that kind of economy.

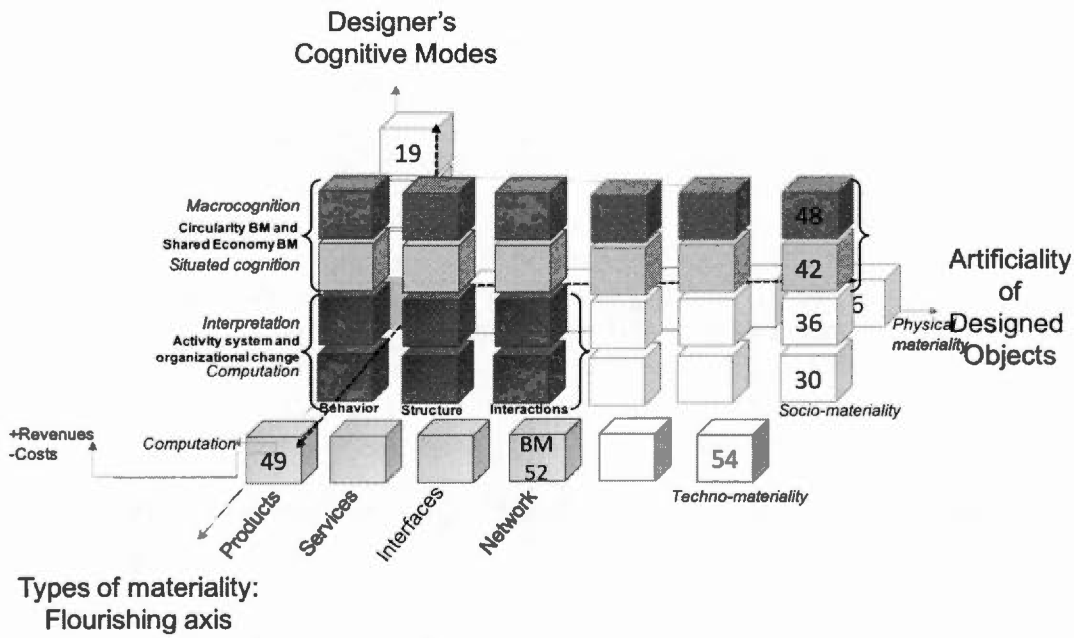

Figure 2.7 Shared Economy and Circular Economy on the FAC Framework

Following Leonardi (2012), the origins of the popularity of the concept of socio-materiality are to be found in the rampant socio-constructivist view in organizational analysis. Technology is much less important than technology-in-use and technology social construction. The author continues:

> To combat this problem, some scholars began advocating that researchers should renew their focus on what features a new technology actually had and what those features did or did not allow people who use them to accomplish

> (Griffith, 1999; Monteiro & Hanseth, 1995; Poole & DeSanctis, 1990). Enter the term Materiality. Orlikowski, (2000: 406), for example, wrote about groupware software that the technology embodies "particular symbol and material properties." She provided several examples of the "material properties" of groupware, which included features contained in the menus that were embedded in the program. (Leonardi, 2012, p. 5)

More and more, researchers are studying materiality aspects (Carlile, P.R. et al., 2013) and are considering materiality as a basic step to reinvent organization theory (Monteiro, P. and Nicolini, D., 2015; Dyck, B., 2016). But in the IT-IS field, the researcher who most promoted socio-materiality as a research approach is clearly Orlikowski, who declared:

> I will demonstrate that while materiality is an integral aspect of organisational activity, it has either been ignored by management research or investigated through an ontology of separateness that cannot account for the multiple and dynamic ways in which the social and the material are constitutively entangled in everyday life. I will end by pointing to some possible alternative perspectives that may have the potential to help management scholars take seriously the distributed and complex sociomaterial configurations that form and perform contemporary organisations. (Orlikowski, 2009: p. 125)

In BM research, Zott & Amit (2010) give a particular status to the activity system, a socio-material system that lies behind any BM and commits to it:

> An activity in a focal firm's business model can be viewed as the engagement of human, physical and/or capital resources of any party to the business model (the focal firm, end customers, vendors, etc.) to serve a specific purpose toward the fulfillment of the overall objective. An activity system is thus a set of interdependent organizational activities centered on a focal firm, including those conducted by the focal firm, its partners, vendors or customers, etc. The firm's activity system may transcend the focal firm and span its boundaries, but will remain firm-centric to enable the focal firm not only to create value with its partners, but also to appropriate a share of the value created itself. (Zott & Amit, 2010: p.2)

Recalling Figure 1.3 on MIT's definition of BM, 'organizational change' clearly belongs to a socio-materiality category like the activity system. Referring back to the

BMF and the physical environment, Bansal & Knox-Hayes (2013) state that socio-materiality is not adapted as a concept to embrace a BMF problematic.

> Organizational sociologists shine their spotlight on organizations. Researchers of sociomateriality have argued that organizations are "produced" by their interaction with the material world. However, this singular focus on organizations has deflected attention from the impact of organizations on the natural environment. The natural environment is not *socio*material; it can exist outside of society. (Bansal & Knox-Hayes, 2013: p. 75)

2.3.3 Conceptualizing BMSs/BMFs: Physical Materiality and Cognition Beyond Computation-Interpretation

The physical environment is not only the locus of natural resources facing depletion but also the target of physical effects generated by human and industrial activity. For some authors the quest for materiality doesn't stop with socio-materiality; physical materiality is required. Winn & Pogutz (2013), for example, propose to explore the links between ecology and management studies:

> This article aims to encourage research into how organizations can manage their relationship with the natural environment so as not to destroy the very life-supporting foundations provided by nature. Bridging knowledge domains, the article introduces key concepts from ecology and social ecology to organization and management studies—*ecosystems, biodiversity, ecosystem services*, and *ecological resilience*. (Winn & Pogutz, 2013, p. 203)

Also, climate change and its physical threats make room for the concept of physical materiality even in specialized investor literature: "The materiality of climate change…clearly shows that climate change risk could have the potential to impact a

Fund's investments over the long term."[17] However, to face climate change, the first business reflex will be to develop 'in vitro' experiments (Callon, 2009), something like carbon markets that are mostly technological and not physical solutions. If the notion of 'flourishing for the future' asks for the acknowledgment of physical materiality in business models and strategies, a lot of sustainable initiatives are abstract techno-solutions, innovative uses of markets without physical materiality. In fact, in the corporate sustainability game, there seems to be at least two games: a 'façade greening' game based on a weak definition of sustainability and a more radical orientation that—like a 'moon shot for management' (Hamel, 2009)—takes up the challenge of making businesses beneficial to the physical environment under the 'flourishing' umbrella. So, to depart from sustainability jargon, Ehrenfeld (see http://www.johnehrenfeld.com/), among others, prefers 'flourishing' as a word and concept:

> My definition of sustainability is fundamentally different. I define sustainability as the possibility that human and other life will flourish on the planet forever. It's a definition about as far from the central notion of sustainable development as night is from day. But, to me, it represents a truer idea about what sustainability is all about. Flourishing, like many other desirable qualities, is an emergent property. It has no thing-like character. It's like health, or liberty, or freedom: It appears only when the whole system is functioning properly. /.../ Now, many people belittle this kind of notion, because in the world of business and management you find the mantra, "if you can't measure it, you can't manage it." But sustainability is not about managing and measuring. It's about getting there, and staying there. (From http://sloanreview.mit.edu/article/flourishing-forever/).

Using this flourishing concept in business model innovation (BMI) is a huge challenge because even 'green' or weakly sustainable business models are not fully

[17] A climate for change, Mercer Investment Consulting, the Carbon Trust, and the Institutional Investors Group on Climate Change, August 2005, available at http://www.mercerIC.com/climateforchange) (MARSH, Risk Alert, Volume V, Issue 2, April 2006, p. 9)

developed in business literature. At this time, Bansal and Hoffman (2012) mention only one article dedicated to sustainable business models by Stubbs and Cocklin (2008).

After several failed attempts to develop an emissions trading system, Japan is developing a unique program that emphasizes bilateral trade and technology transfer, the Bilateral Offsetting Mechanism (also known as the Joint Crediting Mechanism). Through this program Japanese companies directly trade technology for emissions offsets from developing country partners. Japan's refusal to engage in emissions trading is in part structured by its heavy reliance on fossil fuels, as well as its need to reconstitute its energy supply mix. (Know-Hayes, J., 2014, conference abstract)

This is a good example of a technological (not ecological) solution, and a solution that 'speaks' to businessmen and MBA students. MBA students, like people in financial industry, are not familiar with a lot of specialized contributions aimed at redefining ecological management (Cuddington & Beisner, 2005), but:

> For the most part, the MBA students have only been exposed to neoclassical economic thinking within the other MBA subjects. The aim of the sustainability framework is to shift the students' thinking by engaging with sustainability from different perspectives, rather than presenting one version of sustainability to them. The framework has proven to be useful in developing critical and reflective thinking and discussion. (Stubbs & Cocklin, 2008: p. 206)

This can be seen as a "weak" definition of sustainability that retains the same business goals and attitudes. For Byrch et al. (2007), the usual sustainability challenges taken up by companies and governments are about weak sustainability:

> Despite the debate over its meaning, sustainable development, and the related concept of sustainability, would seem to have more proponents than ever. Many individuals and organisations—in particular government and business organisations—are taking up the "sustainability challenge" and incorporating their own understanding of sustainable development into various aspects of

> their operations. In simple terms, the definitions adopted and their respective interpretations demonstrate the relative emphasis given to environmental, social, and economic domains by different groups, and how the concepts of equity, fairness and futurity are applied to those domains. (Byrch *et al.*, 2007: p. 28)

On the other hand, again for Byrch et al. (2007), strong sustainability will require an 'ecocentric' worldview instead of a technocentric or anthropocentric worldview:

> There is a substantial body of literature that suggests that these varying emphases in turn reflect individuals' fundamental beliefs about humanity's proper relationship with nature; that is, their environmental "worldview." Environmental worldviews which are more biocentric are said to lead to significant sustainable environmental performance—although more research is needed to sustain a clear link as worldviews do not always translate into actions consistent with those underlying beliefs. (Byrch *et al.*, 2007: p. 28)

Bansal & Knox-Hayes (2013) argue that:

> the natural environment has a physical materiality that organizations lack. We define physical materiality as objects that have a mass and thereby possess objective temporal and spatial qualities. Because of the emphasis on organizations, prior work has ignored the uniqueness of the natural environment and provided a potentially oversocialized view of the world (p. 62).

Carbon markets illustrate these ideas:

> Whereas carbon possesses physical materiality, carbon markets are social constructions. The instruments developed by carbon markets to manage carbon (i.e. sociomateriality), such as futures and other financial derivatives, compress time and space. Yet the temporal and spatial qualities of carbon (i.e., physical materiality) cannot be easily compressed. (Bansal & Knox-Hayes, 2013)

For Callon (2009), pragmatism is welcome:

> It is because a market is deployed in an uncertain world that it imposes this mixture of agnosticism and experimentation, of trials and errors, observation and evaluation of the effects produced, so typical of a precautionary approach—in this case applied to socio-technical artefacts and not only technological innovations. (Callon, 2009)

The cognition axis can be thought of as a progression through different kinds of contexts imposing both knowledge contents and cognitive process variations. At the origin of the cognition axis lies individual/organizational cognition in a hierarchical context. At the other extremity lies the macrocognition possibility in a non-hierarchical context congruent with Huebner's (2013) three conditions: absence of hierarchal structure, no rules, powerful individual cognition. An illustration of this context might be (Nidumolu et al., 2009) an open sustainability exchange platform inside a business ecosystem. Besides contexts, another dimension is made up of knowledge content, with some tensions between knowledge creation in a traditional paradigm and knowledge use in a sustainability science problem-solving approach. A third dimension encompasses cognitive processes and their logical modes and their boundaries. Is cognition bounded in the mind or does it leak outside into the environment?

Table 2.3 illustrates 24 cells intersecting a cognitive mode with a position on the artificiality trajectory. For example, cell 1 (below, left) expresses a situation in physical materiality where data about a 'place' (whatever the 'place' scale) are computed at a defined time t vs. cell 24, where a group sharing a mental state about the future of their 'place' is backcasting together, looking for F-practices capabilities able to physically change their 'place.' Chapter four will detail the way we parallel artificiality trajectory with a concrete/abstract trajectory on the physical materiality axis. As mentioned earlier, situated cognition and macrocognition can happen on the socio-materiality axis too. In this case, the physical environment is an actor no more; this is the realm of shared economy and circular economy (Jonker, 2012) where good practices like recycling and dematerializing are substitutes from the analysis of the physical environment.

Table 2.3 Physical Materiality: Artificiality Trajectory and Cognitive Modes

19 MACROCOGNITION : SHARED MENTAL STATES ABOUT A PHYSICAL PLACE AT TIME t	20 MACROCOGNITION : SHARED MENTAL STATES ABOUT ECOLOGICAL SERVICES	21 MACROCOGNITION : SHARED MENTAL STATES ABOUT HUMAN/NATURE INTERACTIONS	22 MACROCOGNITION : SHARED MENTAL STATES ABOUT F-PRACTICES PLATFORM	23 MACROCOGNITION : SHARED MENTAL STATES ABOUT OF F-PRACTICES CAPABILITIES	24 MACROCOGNITION : SHARED MENTAL STATES AND GROUP BACKCASTING
13 REAL-TIME SITUATED COGNITION OF A PHYSICAL PLACE AT TIME t	14 REAL-TIME SITUATED COGNITION OF ECOLOGICAL SERVICES	15 REAL-TIME SITUATED COGNITION OF HUMAN/NATURE INTERACTIONS	16 REAL-TIME SITUATED COGNITION OF F-PRACTICES PLATFORM	17 REAL-TIME SITUATED COGNITION OF F-PRACTICES CAPABILITIES	18 SITUATED COGNITION AND REAL-TIME BACKCASTING
7 DATA INTERPRETED ABOUT PHYSICAL PLACE AT TIME t	8 DATA INTERPRETED ABOUT ECOLOGICAL SERVICES	9 DATA INTERPRETED ABOUT HUMAN/NATURE INTERACTIONS	10 DATA INTERPRETED ABOUT F-PRACTICES PLATFORM	11 DATA INTERPRETED ABOUT F-PRACTICES CAPABILITIES	12 DATA INTERPRETED ABOUT BACKCASTING
1 DATA COMPUTED ABOUT PHYSICAL PLACE AT TIME t	2 DATA COMPUTED ABOUT ECOLOGICAL SERVICES	3 DATA COMPUTED ABOUT HUMAN/NATURE INTERACTIONS	4 DATA COMPUTED ABOUT F-PRACTICES PLATFORM	5 DATA COMPUTED ABOUT F-PRACTICES CAPABILITIES	6 DATA COMPUTED ABOUT BACKCASTING

Cognitive sciences historically are divided into paradigms. To gain a nuanced and fine-grain history of cognition applied this time to innovation management, Nooteboom (2009) makes a critical review of the evolution of cognitive sciences. Here are the main steps of cognition science history identified by Nooteboom (2009). First comes the traditional view, more specifically (p. 37) the 'computational view'; the traditional view is then followed by 'situated action,' 'constructivist,' or 'embodied cognition' view (p. 40). Nooteboom derives some key lessons from his understanding of cognition around the issue of 'cognitive distance':

> If cognitive capability is constructed from situated action, people will perceive, interpret, understand and evaluate the world differently to the extent that they have constructed their cognition along different, weakly connected life paths. This yields the notion of 'cognitive distance' (pp. 66–67).

But an organization cannot be efficient without strategic focus limiting the cognitive distance consequences:

> Thus, organizations require an organizational 'cognitive focus,' to sufficiently limit cognitive distance, for the sake of sufficient mutual understanding and ability to collaborate. This yields both a strength compared with markets, in favouring collaboration, and a weakness, in reducing cognitive variety. To compensate for this, firms need relations with other organizations, at larger cognitive distance. (p. 67)

So, one of a BM's cognitive aspects may be to reduce cognitive distance and promote organizational cognitive focus (i.e. focus on flourishing life), especially in business ecosystems where cognitive distance can be overstretched. Nooteboom (2009) seems to leave behind him the computational view. However, this view, which assimilates the brain to a computer architecture, is the most current analogy in neurosciences, except for a few scientists, like Epstein[18] who states:

> We are organisms, not computers. *Get over it.* Let's get on with the business of trying to understand ourselves, but without being encumbered by unnecessary intellectual baggage. The IP (Information Processing) metaphor has had a half-century run, producing few, if any, insights along the way. The time has come to hit the DELETE key.

Following Lant & Shapira (2000), in management sciences, computation and interpretation are both required to generate *organizational intelligence.* March, quoted by Lant & Shapira (2000), outlines two critical problems in the pursuit of intelligence in organizations:

> The first, *ignorance*, is essentially a problem of computation. Intelligent action requires information and prediction. /.../ given sufficient data, theories about cause and effect, and a well-defined payoff matrix associated with uncertain outcomes, this problem boils down to one of computation. The second

[18] https://aeon.co/essays/your-brain-does-not-process-information-and-it-is-not-a-computer

> problem, *ambiguity*, is a problem of interpretation. To assess intelligence, one has to know what outcomes are desired and know when outcomes have been achieved. (Lant & Shapira, 2000: p. 7)

So, hierarchical context can be associated first with computational view but this view needs its interpretational view complement. Strictly speaking, it makes sense to have the 'Physical environment' cube at the origin of the three axes model: it is concrete (low on the artificiality axis), belongs to physical materiality and can be monitored through computation (sensors connected to computers). It shows the distance between, for example, carbon cycles (cube 1) and carbon market BM design and applications (cube 52) dedicated to sustainability reporting and computation.[19]

Moore (2006, 2007) has worked in particular on logical steps by which pressure groups and managers of a city eventually implement all or some aspects of sustainability. For Moore (2007), the logic of managers, based on the definitions of sustainable development such as that found in Brundtland Report (1987), falls into the category of logical *deduction*; managers who found their sustainability initiative in environmental *reporting* standards are in a process of *induction*, while managers who trust their common sense have limited means and say "*Let's see what happens and what works*" and work in a logic of *abduction* by formulating new hypotheses. Figure 2.2 shows that a BMF case can be expanded over the three dimensions of cognition, flourishing and artificiality.

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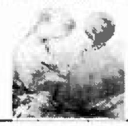
[19] http://www.sap.com/solution/lob/sustainability/software/performance-management/index.html, visited on December 20, 2014.

	Introduction of the 'sustainability' word in management and BMI		*Introduction of the natural environment in our lives*
	Weak Sustainability	**Strong Sustainability**	**Flourishing Life**
Cognition	Computation & Reporting Global Reporting Initiative™	Interpretation 	Situated - Embodied 
Tools	Variables' Lists, Measures, Computes Value of Sustainable Actions	 Brundtland Sustainable Development Definition	My Body My Emotions
Logical Mode	Induction	Deduction	Abduction

2

Figure 2.6 Cognition and Sustainability Approaches

It can be asserted that a mature BMF should occupy the whole space between the three axes. By contrast GRI reporting initiatives represent a small surface between service on the artificiality trajectory, induction on the cognition axis and techno-materiality on the flourishing axis.

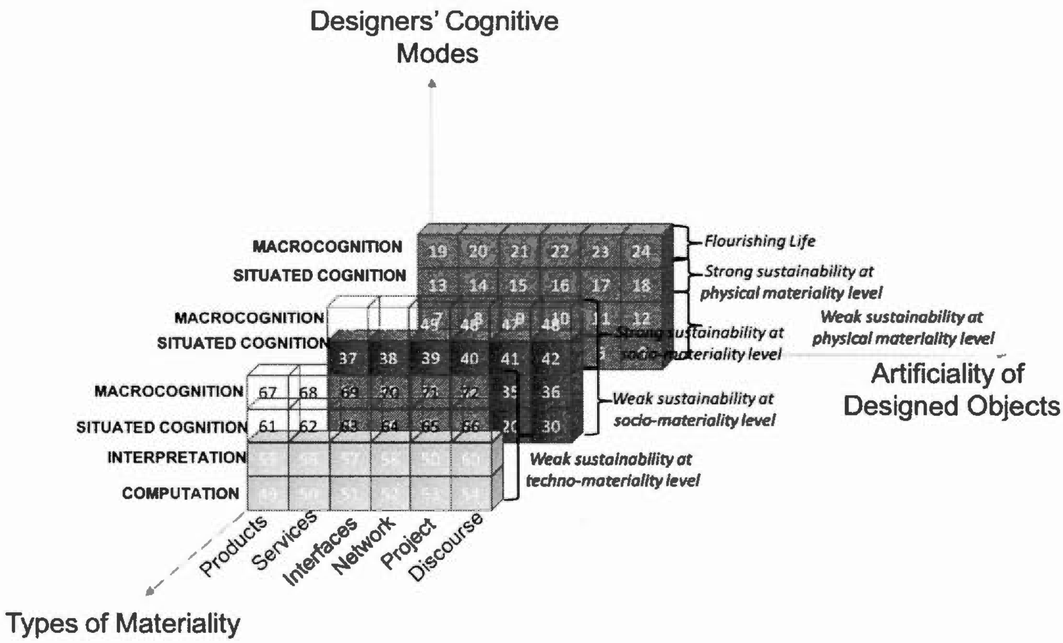


Figure 2.8 FAC 72 Cubes to Capture Elements for a BM/BMF

Bruntdland's definition of sustainable development encompasses the three types of weak sustainability indicated on Figure 2.7: weak sustainability at techno-material, socio-material and physical levels. Computation illustrates all the environmental accounting efforts generated by the concept of sustainable development; the interpretation illustrates all the deductive logical effort made by people interpreting 'sustainable development' concept coined by Bruntdland et al. in their 1987 report.

Sustainability reporting (Global Reporting Initiative, Figure 2.5) is rapidly becoming a mature field, and businesses are providing far more insight into their operations than even just a few years ago. However, analyzing and comparing business sustainability reports can be a cumbersome, time-consuming process. To be a truly useful tool for investors and community stakeholders, reporting needs to be streamlined, standardized and, above all, integrated into electronic platforms. That is the motivation behind a new format for sustainability reporting that will be developed by the sustainability reporting organization *Global Reporting Initiative* in partnership with Deloitte, the global financial consulting firm. (http://www.triplepundit.com/2011/06/xbrl-sustainability-data/). Noteboom (2009) misses macrocognition as an ultimate cognition state where a BMF becomes a shared public object (cognitive artefact).

Weak sustainability relates to organizational computation by a main challenge: the challenge of *calculating* how big the compensation in capital would be for the loss of natural goods as discussed by Nilsen in her thesis (Nilsen, H.R., 2010). This challenge can also be linked to the GRI reporting practices. The computational approach to sustainability can be equated with an approach that is defined by digital computer use. But even the organizational sustainability computationalists should work on an interpretation of the concept of sustainability, and they will quickly reframe it in a dynamic systems approach (Sommer, 2012).

Management and strategic management as disciplines have a strong bias in favour of concepts like mental or causal schemas that are travelling inside the heads of managers. This mental model can exist at individual, team, group or organizational level. Why are these mental schemas necessary? Researchers in experimental psychology who resisted the new paradigm of cognitive science around 1980 derived the mental model concept. There was a debate at that time as to whether we could talk about a mind model without addressing AI (artificial intelligence), namely the existence of rules as symbolic representation. Johnson-Laird (1980: 73) stated that:

> Philosophers distinguish between a correspondence theory of truth and a coherence theory. An assertion is true according to the first theory if it corresponds to some state of affairs in the world; and it is true according to the second theory if it coheres with a set of assertions constituting a general body of knowledge. Psychologists want their theories to correspond to the facts; artificial intelligencers want their theories to be coherent; both groups have

> adopted the methods best suited to their aims. Cognitive science, however, needs theories that both cohere and correspond to the facts. Hence a rapprochement is required.

In the strategic management field, cognitive schemas seem to be linked with long-term storage and hence are interacting with situated cognition where meaning is built on the fly, in real-time, during interactions between people and artefacts. As Gioia (in Lant & Shapira (Eds.) 2001, 2008) wrote as a final comment on several chapters about strategy and cognition: "As for their more apparent themes, they all employ the notion of mental models for understanding and action and they all have the notion of cognitive schemas (either implicit or explicit) as a conceptual basis for the issues they consider" (p. 345). In terms of processes, the cognition axis represents at its origin processes inside the mind. And, at the other extremity, it represents processes that leak outside the mind as described by terms such as situated cognition or macrocognition.

Logical modes also differ. The origins of the cognition axis are connected with induction and deduction as logical modes; at the other extremity reigns abduction as logical mode.

At its roots, the cognition axis represents the analytical aspect of the scientific method: together hypothesis, experiment and theory make up the method science uses to examine" the real to create knowledge. At the other extremity, knowledge must be used to create a new reality through new artefacts. In this case, science is a science of synthesis using abduction as logical mode to solve complex problems. Applying 'sustainable' science concepts in managerial contexts forces managers to deal with their cognitive, as well as time and resource, limitations:

> In contrast to the myths and stories of ancient peoples, the underlying knowledge and reasoning of contemporary societies is grounded in science. Of course, not everybody can be expected to mobilize complex, science based belief patterns prior to every environmental management decision. Instead, we deal with our cognitive limitations by condensing real world complexities into

> simple conceptual blends that capture their pragmatic relevance. (Antal & Hukkinen, 2010: p. 941)

In a 1999 report, the National Council of Scientific Research (NRC) in the United States defined the research priorities for the *science of sustainability.* The Council set the following priorities:

- To develop a research framework that integrates global and local perspectives to shape a "place-based" understanding of the interactions between environment and society.
- To initiate focused research programs on a small set of understudied questions that are central to a deeper understanding of interactions between society and the environment.
- To promote better utilization of existing tools and processes for linking knowledge to action in pursuit of a transition to sustainability.

The object of the science of sustainability is built from multiple movements to harness science and technology to develop sustainability by focusing on the dynamic interactions between nature and society, with equal attention given to the way in which social change affects the environment and how the environment is changing society. These movements want to address the essential complexity of these interactions, recognizing that understanding the individual components of the nature-society system provides an insufficient understanding of the behavior of these systems. Problem-driven approaches exist with the goal of creating and applying knowledge to assist decision-making for sustainable development. One of the foundational beliefs of these approaches is that this knowledge must be co-produced by both researchers and practitioners (Clark & Dickson, 2003).

The work of Kumazawa et al. (2009) designed the structure of sustainability science knowledge and has helped others think further about this topic. It focuses on the identification of requirements for structuring knowledge while providing a reference model and developing a mapping tool based on ontology.

The science of sustainability requires a fully open approach that reflects interdisciplinary challenges. A platform must be built to replace the piecemeal approach with an approach to find comprehensive solutions to problems (Kumazawa et al. 2009). This approach requires a reorganization of disparate fields of knowledge; hence, the challenge to create a structure specific to the science of knowledge sustainability. Other approaches, such as that of Kumazawa et al. (2009), were also explored. The Global System for Sustainable Development (GSSD) was developed at MIT. In the UK, the Millennium Ecosystem Assessment is a related project.

Regarding problem solving, the approaches of engineers and environmental economists differ. "In other words, Sustainability Science (SS) researchers are neither sure of what they want to look for by structuring knowledge in SS, nor do they share a common understanding of what is required in order to achieve the structuring of knowledge." (Kumazawa et al., 2009: p. 101).

> Different forms of uncertainty are at the heart of environmental decision-making, among them epistemic uncertainty, which arises when the normal, disciplinary forms of uncertainty reduction fail and which leads to debate on adequate ways of coping with uncertainty. Epistemic uncertainty in environmental issues may call for a different type of science that differs from normal, positivist science. Such post-normal science is transdisciplinary, participative and context sensitive in that it aims at the production of knowledge for concrete, real-world problems. New forms of knowledge production such as the concept of post-normal science in conjunction with the precautionary principle challenge the established authority of science and may lead to an institutional split of science into an academic branch and a managerial, public policy branch. (Haag & Kaupenjohann, 2001: p. 45)

2.4 Methodological Approach: Action Research and Design Science

Checkland and Holwell (1998) have redefined action research (AR), its nature and its validity. We follow this methodological approach in this thesis because of its openness and flexibility. AR clearly makes the distinction between *a priori* framework (F), a portfolio of available methods (M), the area of concern (A) and the lessons learned from F, M, and A during repeated iterations. In concordance with AR, this thesis starts with an elaborated framework (FAC), defines M as a mix of action research and design science plus analysis techniques like video- and audio records coding and personal observations notes from experiments based on OA, BMC and gamestorming (supported with a table game), defines two areas of concern A (EMBA classroom and SD unit inside a large Canadian city) and, through multiple iterations, identifies key lessons learned. Per Checkland, researcher(s) and area(s) of concern morph into a soft learning system, a classroom and SD unit, where members struggle to maintain human relationships while defining common standards.

> The concept emerged of a researcher immersing himself or herself in a human situation and following it along whatever path it takes as it unfolds through time. This means that the only certain object of research becomes the change process itself. This is a difficult concept for those anxious to import hypothesis-testing into social research, though it is an approach with which anthropologists and sociologists are familiar. /.../ This is something which worries natural scientists and those who would emulate their method of inquiry. As Vickers used to point out (Checkland, and Holwell, 1997, p. 19), since social phenomena are mental abstractions at a meta-level to their manifestations, even *thinking and arguing* about them can change them! (Checkland & Holwell, 1998: p. 11)

But the AR methodological approach must be completed by design science (DS) because our third research objective is to transfer lessons learned into high-level virtual tutor requirements. Experiments, observations and analysis will generate some results regarding the BM and BMF differences interpreTable in the FAC framework on cognition, artificiality and flourishing themes and as learning processes.

Are AR and DS compatible? Järvinen (2007) finds that AR and DS are similar. At the end of a deep analysis, he came up with the following table:

Table 2.4 Similarities of Fundamental Characteristics of Action Research and Design Science

AR – Action Research	DS – Design Science
AR-1: Action research emphasizes the utility aspect of the future system from the people's point of view.	DS-4: Design science's products are assessed against criteria of value or utility.
AR-2: Action research produces knowledge to guide practice in modification.	DS-2: Design science produces design knowledge (concepts, constructs, models and methods).
AR-3: Action research means both action taking and evaluating.	DS-3: Building and evaluation are the two main activities of design science.
AR-4: Action research is carried out by the action researcher and the client system in collaboration.	DS-5: Design science research is initiated by the researcher(s) interested in developing technological rules for a certain type of issue. Each individual case is primarily oriented at solving the local problem in close collaboration with the local people.
AR-5: Action research modifies a given reality or develops a new system.	DS-1: Design science solves construction problems (producing new innovations) and improvement problems (improving the performance of existing entities).

AR-6: The researcher intervenes in the problem setting. AR-7: Knowledge is generated, used, tested and modified over the course of the action research project.	DS-6: Knowledge is generated, used and evaluated through the building action.

As stated in Table 2.4, both AR and DS require the active involvement of the researcher/designer in a constant relationship with the people in the area of concern. Constructing a solution to an organizational problem or building an artefact are quite similar; in both cases, awareness of the problem is key. Järvinen (2007) borrows the following description of DS process (Figure 2.9) from Vaishnavi and Kuechler (2004).

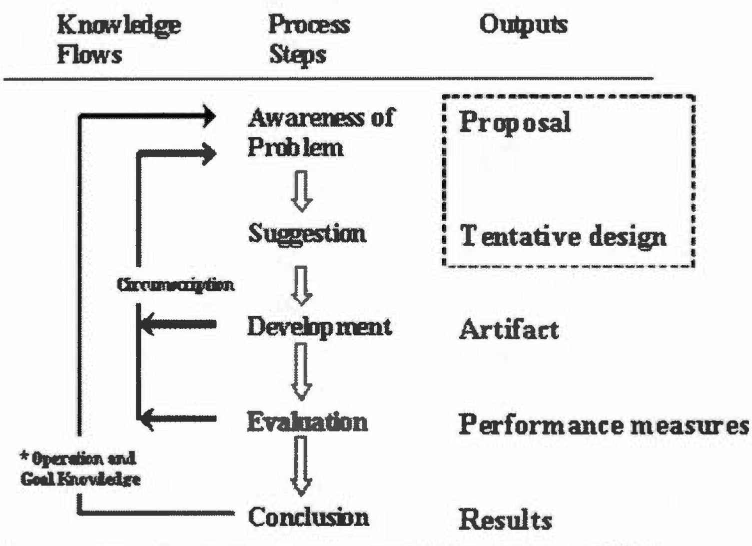


Figure 2.9 The General Methodology of Design Research

Source: Järvinen, 2007: p. 49.

They underscore the fact that suggestions for a problem solution are abductively drawn from existing knowledge/theory base for the problem area (area of concern in AR).

In their design science portal Vaishnavi and Kuechler (2004) describe the general methodology of design research in (Figure 2.9). They describe steps as follows:

> "In this model all design begins with Awareness of a problem. Design research is sometimes called 'Improvement Research' and this designation emphasizes the problem-solving/performance-improving nature of activity. Suggestions for a problem solution are abductively drawn from existing knowledge/theory base for the problem area. An attempt at implementing an artefact according to the suggested solution is performed next. This stage is shown as Development in the diagram. Partially or fully successful implementations are then Evaluated (according to the functional specification implicit or explicit in the suggestion). Development, Evaluation and further Suggestion are frequently iteratively performed in the course of the research (design) effort. The basis of the iteration, the flow from partial completion of the cycle back to Awareness of the Problem, is indicated by the Circumscription arrow. Conclusion indicates termination of a specific design project." (Järvinen, 2007: p. 49)

Given such characteristics as abduction, iterations, involvement and participation of the researcher in the area of concern, AR and DS are more than compatible; they complement each other when a built artefact can contribute to problem solving in the area of concern. Petersson and Lundberg (2016) push the envelope further and propose a fusion of AR and DS to form a new approach: action design research (ADR).

> ADR was proposed by Sein et al. [5] in an effort to blend design research with action research. Design science is the study of artefacts in their context [6], whereas action research is intervention in a social situation in order to both improve this situation and learn from it [7]. The purpose of ADR is to generate prescriptive design knowledge through learning from the intervention of building and evaluating an artefact in an organizational setting to address a problem[5]. (Petersson and Lundberg, 2016: p. 222)

Petersson and Lundberg (2016) create a new graph to illustrate a fusion between AR and DS.

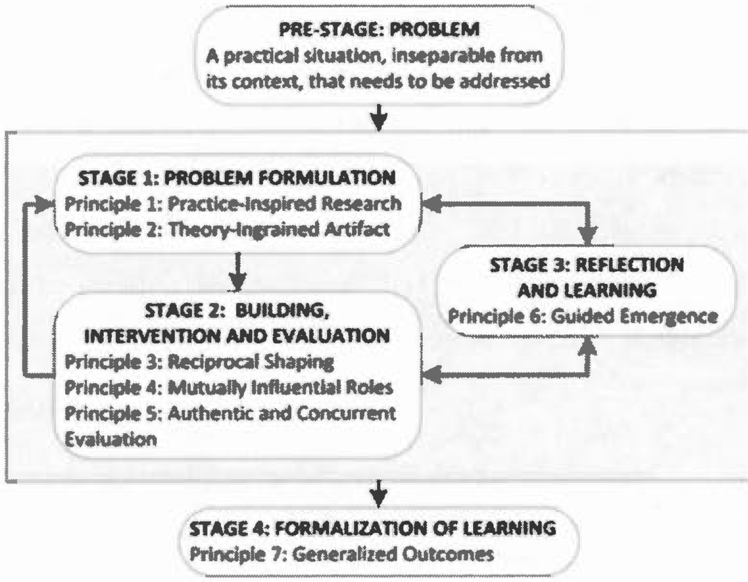


Figure 2.10 The Stages of ADR

Source: Petersson and Lundberg (2016), p. 223.

Going back to AR and Checkland, a framework can be parallel to Pre-Stage Problem, Method with Problem Formulation, Area of Concern with Building, Intervention and Evaluation and finally Learning with Reflection and Learning and Formalization of Learning. In this thesis, chapter one can be associated with Pre-Stage: Problem; chapter two with Problem Formulation; chapters three and four with Intervention (Stage 2); chapters five and six with Building and Evaluation (Stage 2). Reflection and Learning from interventions with BMC and gamestorming are part of chapters three and four, while Reflection and Learning on the artefact (a future tutor) are part of chapters five, six and seven.

2.5 Areas of concern

Two areas of concern (referring to AR) or intervention fields (referring to ADR) are chosen in this thesis. The first is an EMBA session class, and the second is a SD unit in a large Canadian city. The first tackles the challenge of teaching sustainability to professional students, and the second explores the different meanings of sustainability (BMSs vs BMFs) enacted in a table game developed for this thesis. These interventions fit perfectly with the F-M-A-L parts of Checkland's AR model. They are not as good a fit with the ADR model because the artefact design issue was considered only after the interventions in the field.

2.5.1 Teaching EMBA and Professional Students

Being a teacher, I try to make room for sustainability related issues in my various courses. Since the fall 2013 session, I have been performing the experiment in all my courses with new material (cases in sustainability and new applications and practices in the field of Green IT and IT for Green).

The research intervention in an EMBA classroom is presented at Figure 2.11. In the EMBA classroom, an experiment will be conducted around the Pinnacle West case for five months. In the context of an inverted classroom, the author of this thesis will act as a tutor and interface with students through direct contact and through an intelligent environment. At the end of the session, EMBA students will be asked to complete an BMC showing a green BM or BMS.

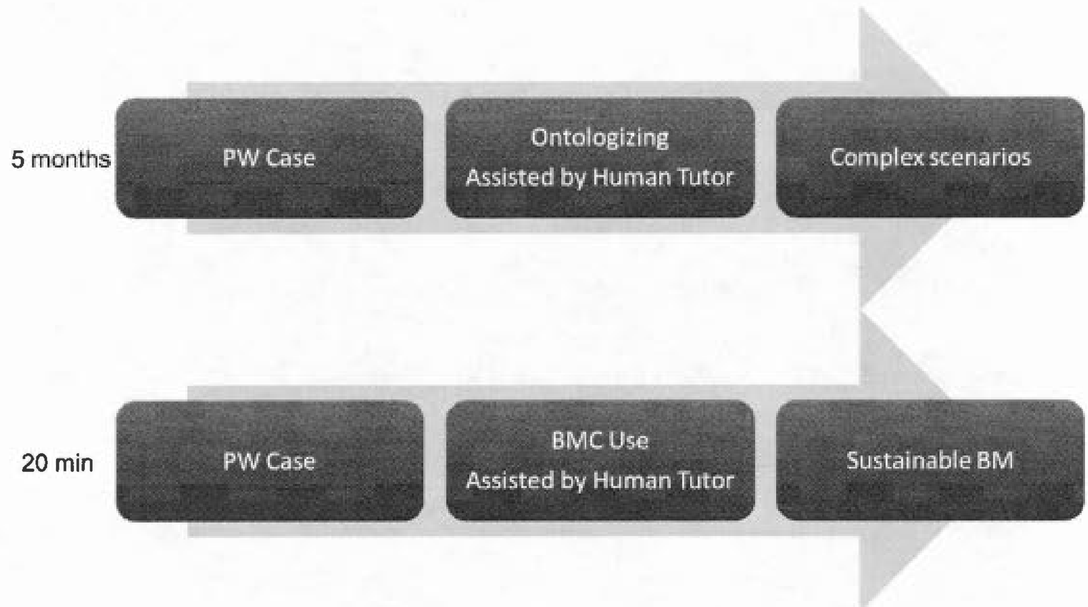


Figure 2.11 Two Interventions in an EMBA Classroom

2.5.2 Sustainable Development Unit in a Large Canadian City

A table game—Logim@s©—is invented and played by large city sustainability unit's managers. They learn the game and become users of various artefacts with the aim of producing a BMF using mostly BMC categories. For Krippendorff (2007), in the case of a virtual tutor, the man/machine interface should be considered as an artefact too.

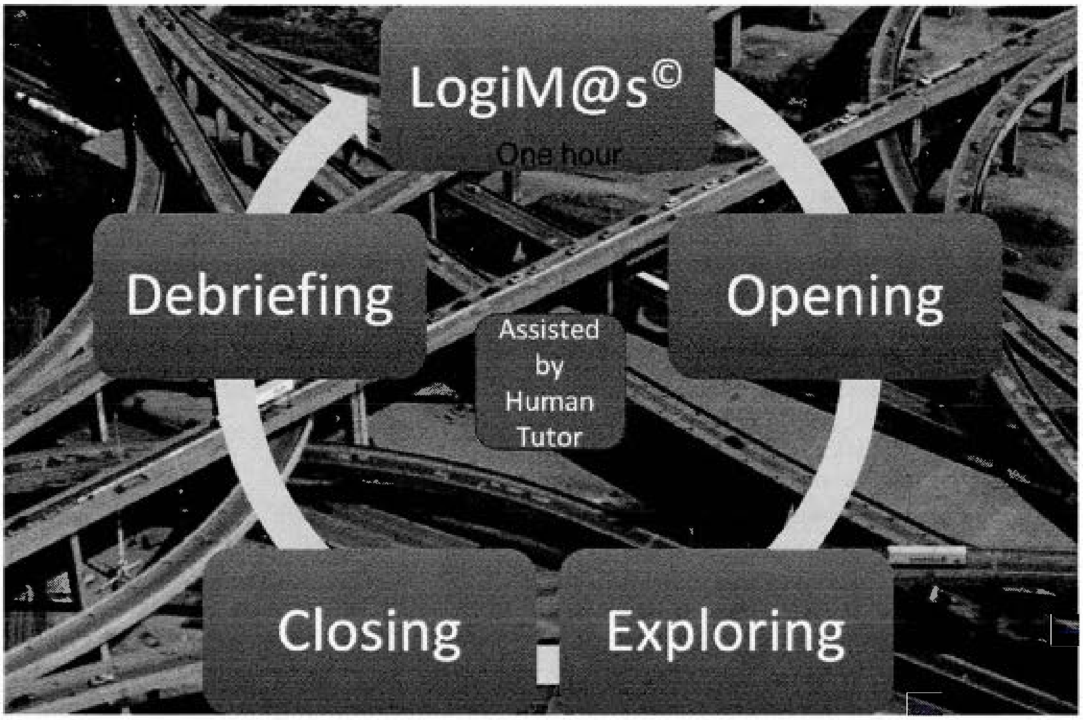


Figure 2.12 Playing LogiM@s© with SD Unit Managers

City sustainability managers are not used to working with the BMC approach, but they are invited to practice this approach to model the benefits of an infrastructure project constrained by different environmental discourses in four cities. The cities cases are borrowed from Moore's book (2007) describing sustainability processes in Austin, Curitiba and Frankfurt; a Canadian city is added. Large cities are well organized into networks and are continuously innovating with regard to sustainability; unlike companies, cities occupy a defined physical space and work within a "place-based" problem mindset, as in sustainability science.

2.6 Learning Objectives

Our research problem is vast but it can be melted down, with the help of our FAC research framework, by describing our research objectives and questions.

2.6.1 Research Objectives

1. Evaluate traditional BM gamestorming usefulness in the context of BMS/BMF design. Even if this thesis' objective is not to discuss traditional BM design, research design will let students and managers use a traditional BM canvas in the context of BMS/BMF design. This thesis' results may shed some light on traditional BM canvas transposition in a BMF design context.
2. Experiment FAC research framework robustness by organizing practical experiments other than the traditional BMC approach. This experimentation is done in two different contexts. First, there is an ontologizing approach within an EMBA classroom to develop methods and practices of collaboration, even inverted teaching, around the Pinnacle West case mentioned earlier. This experiment is designed to push the envelope on the cognition axis. Second, a table game is invented and played by city sustainability managers who will need to use a BM canvas to develop a BMS/BMF. Here, fluid navigation is the essence, especially between discourses and BM-BMF's products and services. This thesis' results may contribute to defining the learning processes implicit in various activities intended to stimulate BMF design like gaming, gamification, serious gaming and gamestorming.

3. Transfer lessons learned into high-level virtual tutor requirements. Experiments, observations and analysis will generate some results regarding any BM and BMF differences interpreTable in the FAC framework on cognition, artificiality and flourishing themes and as learning processes in the Beckman & Barry (2007) dynamic framework.

The author of this thesis has conducted these experiments himself; therefore, the third objective is to define and transfer key use cases that could be instructive into a UML language to specify a virtual robot dedicated to gamestorming and mobile learning.

2.6.3 Research Propositions

As stated in the introduction, the practical problem for managers and students is to design and implement a BMF with strong sustainability in mind and this thesis' presupposition is that usual BM design through BMC gamification doesn't fit BMF design requirements because BMC gamification is conceived without macrocognition/situated cognition, without fluid navigation on artificiality axis and in a context of techno-materiality. Chapter one stated that a BM for digital value is associated with computing as a cognitive mode, and, as the computation is done inside a business hierarchy, essentially about 'what if?' questions related to fixed categories. This BM computation aims at creating a VBM as strategic driver for investors, shareholders and strategic managers.

- VBM BMC-based design research propositions are:

    A. VBM BMC-based thin design experiment tends to limit players/designers' moves on one axis: techno-materiality.
    B. VBM BMC-based thin design experiment tends to limit players/designers' focus on 'network' position on artificiality trajectory.

C. VBM BMC-based thin design experiment tends to limit players/designers' cognitive modes to computation/interpretation in a hierarchical context with few powerful people.

D. VBM BMC-based approach connects with sustainability issue(s) in a design stance.

In VBM BMC-based design, Nature is not considered as an actor and the physical problems are not considered from a sustainability science point of view.

Architectural BMs don't imply spreadsheet use but a visualization process leading to the discovery of new organizational capabilities supported by new platform capabilities in an emerging way. BMs become a strategic driver not only for investors, shareholders and managers but also for user communities and actors in the supply chain. Those BMs are still designed inside a hierarchy, but designers are developing new bonds with different communities of users in an interpretation mode, from a cognition standpoint. ABMs can be mainly designed inside a thin BMC approach; in this case, VBM research propositions still apply. Or ABMs are designed from an organizational architecture approach (OA); in this case, new research propositions can be devised. This OA approach can be extended to the whole society through an SA (Societal Architecture) approach leading to new large scale BMs like shared economy and circular economy.

- So, ABMs with OA-SA design approach research propositions are:

  A. ABMs with OA-SA design experiment tend to limit players/designers' moves on two axes: techno-materiality and socio-materiality.

  B. ABMs with OA-SA design experiment tend to limit players/designers' focus on 'network' on the artificiality trajectory and 'vision,' 'capability' and 'platform' on the socio-materiality axis.

C. ABMs with OA-SA design experiment tend to limit players/designers' cognitive modes to computation/interpretation in a societal context.

D. ABMs with OA-SA design approach connect only indirectly with sustainability issue(s), in an intentional stance.

ABMs with OA-SA design propose new capabilities like recycling, dematerializing, choosing services over products etc. that are by design good for the physical environment. However, the physical environment is not a part of ABM design with OA-SA.

BMFs, BMs for flourishing future, represent a turning point in a family of more or less sustainable BMs. BMF designers, following Ehrenfeld (2005, 2008), chose to cut their design program from hierarchical constraints and pressures to focus on life on earth. This is a radically new program for business hierarchies whose managers and members should change their cognitive modes toward new modes like situated cognition and macrocognition, thereby attracting citizens and customers and easing their environmental concerns.

- Conversely, BMF design approach research propositions are:

A. BMF thick design experiments tend to extend players/designers' moves on three axes, i.e. techno-materiality, socio-materiality and physical materiality.

B. BMF thick design experiments tend to multiply players/designers' moves from product to discourse, back and forth on techno-materiality axis; from behavior to vision, back and forth on socio-materiality axis; from physical environment state to backcasting, back and forth on physical materiality axis.

C. BMF thick design experiments tend to extend roles and categories of players/designers' and their cognitive modes from computation and interpretation to situated cognition and macrocognition.

D. BMF approach connects with sustainability issue(s) in a physical stance.

As experiment triggers, this thesis rests on two inventions: an MBA classroom concept where a solution to a business case problem will be worked out during a session focused on reverse-learning and an original table game designed to be tested by SD managers and professionals. For each experiment, a world (a space game) had to be invented and key artefacts developed, like websites, cards and rules of the game. In this thesis, the genesis of these "inventions" is not discussed; it is taken as a given.

As exploratory research, this thesis won't test and verify all its research propositions. This thesis' contribution is to make research propositions emerge from exchanges between individuals experimenting with the FAC framework through dedicated activities and a table game.

2.7 Conclusion

In this thesis, a lot of the work done by the researcher and the participants is about artefact design in a ADR approach. Goel (2014) proposes designing artefacts within the scope of a creative activity with both lateral and vertical transformation. Lateral transformation broadens the problem space while vertical transformation deepens the problem space. Table 2.5 offers a summary of our research propositions.

Table 2.5 Summary of Research Propositions

VBM BMC-based design research propositions	ABM with OA-SA design approach research propositions	BMF design approach research propositions
A. VBM BMC-based thin design experiments tend to limit players/designers' moves on one axis: techno-materiality	A. ABM with OA-SA design experiments tend to limit players/designers' moves on two axes: techno-materiality and socio-materiality axes	A. BMF thick design experiments tend to extend players/designers' moves on three axes, i.e. techno-materiality, socio-materiality and physical materiality
B. VBM BMC-based thin design experiments tend to limit players/designers' focus on 'network' position on artificiality trajectory	B. ABM with OA-SA design experiments tend to limit players/designers' focuses on 'network' on artificiality trajectory and 'vision,' 'capability' and 'platform' on socio-materiality axis	B. BMF thick design experiments tend to multiply players/designers' moves from product to discourse, back and forth on techno-materiality axis; from behavior to vision, back and forth on socio-materiality axis; from physical environment state to backcasting, back and forth on physical materiality axis
C. VBM BMC-based thin design experiments tend to limit players/designers' cognitive modes to computation/interpretation in a hierarchical context with few powerful people	C. ABM with OA-SA design experiments tend to limit players/designers' cognitive modes to computation/interpretation in a societal context	C. BMF thick design experiments tend to extend roles and categories of players/designers' and their cognitive modes from computation, interpretation, to

		situated cognition and macrocognition
D. VBM BMC-based approach connects with sustainability issue(s) in a design stance	D. ABM with OA-SA design approach connects only indirectly with sustainability issue(s), in an intentional stance	D. BMF approach connects with sustainability issue(s) in a physical stance

> The process of designing artefacts is a creative activity. /…/ The process of artefact design requires the judicious application of both lateral and vertical transformations. (Goel, 2014: p. 1)

Conducting an ontologizing experiment in a classroom setting (chapter three) is a vertical transformation of the problem space:

> The refinement and detailing phases are more constrained and structured. They are phases where preconstructed concepts are manipulated. Commitments are made to a particular solution and propagated through the problem space. They are characterized by the concrete nature of information being considered, a high degree of commitment to generated ideas, attention to detail, and a large number of vertical transformations. A vertical transformation is one where movement is from one idea to a more detailed version of the same idea. It results in a deepening of the problem space. The rules underlying vertical transformations can often be articulated. (Goel, 2014: p. 6)

Game, gamestorming and gamification represent a lateral transformation of the problem space:

> Preliminary solution generation is a classic case of creative problem solving. It is a phase of "cognitive way-finding," a phase of concept construction, where a few kernel ideas are generated and explored through lateral transformations. A lateral transformation is one where movement is from one idea to a slightly different idea rather than a more detailed version of the same idea. Lateral transformations are necessary for the widening of the problem space and the exploration and development of kernel ideas. This generation and exploration

> of ideas/concepts is facilitated by the abstract nature of information being considered, a low degree of commitment to generated ideas, the coarseness of detail, and the number of lateral transformations. (Goel, 2014: p. 6).

With the design of a research paradigm in mind, this research starts by inventing two things: a classroom experiment and a table game, both connected by sustainability. During the two experiments, the author acts as a classroom and game tutor guiding users toward a result: the design of a BMF. Practically speaking, MBA students are challenged in a classroom setting regarding an organizational architecture where traditional energy producers use mainly coal and nuclear energy.

CHAPTER III

BUSINESS MODEL CANVAS (BMC) VS. ORGANIZATIONAL ARCHITECTURE (OA): AN INVERTED CLASSROOM EXPERIMENT

3.1 Introduction

Susman and Evered (1978) were among the first scholars in organizational science to promote action research. They wrote: "Many of the findings in our scholarly management journals are only remotely related to the real world of practicing managers /.../" (1978, p. 582). More recently action research has been updated by scholars in MIS (Baskerville & Myers, 2004; Lindgren *et al.*, 2004) where the teacher acts as the researcher. As a teacher, he designs all the course material, and as a researcher he observes learning processes using different media (audio or video meetings, online content, events, web links, references, etc.) plus recorded sequences in the classroom. A research assistant helps him by capturing video sequences. During the session, the teacher is devoted to the students' progress. He works closely with the four teams, helping them grow and climb the ladder leading from factual knowledge to conceptual and then procedural and strategic knowledge. During their work on Pinnacle West (PW) problems, teams create impressive knowledge bases leading to scenarios enabling business problem solutions. Simon wrote a long time ago: "*/... /solving a problem simply means representing it so as to make the solution transparent*" (Simon, 1996:153). In this vein, thousands of connected terms form a solid and detailed representation of the problem. Recently, Wang et al. (2013: p. 293) wrote:

> For effective learning through practical experience, problem solving and knowledge construction should be highly integrated and reciprocally reinforcing. However, both knowledge construction and problem solving are complex cognitive processes, which cannot be easily captured and mastered.

This chapter takes stock of a teaching/learning experiment with an MBA classroom in which students had to handle—in the same course—both Business Model Canvas (BMC) and a rather abstract organizational modeling (OM) (Morabito and al., 1999) connected to knowledge management (KM) approaches (Lillehagen & Krogstie, 2008), as well as notions of innovation and ICT platform management (Fransman, 2010). This learning experiment is a case of thick design inside an inverted classroom. Figure 3.1 clarifies this chapter's research proposition, which can be expressed as follows: a BMF thick design experiment tends to extend the roles and categories of players/designers' and their cognitive modes from computation and interpretation to situated cognition and macrocognition.

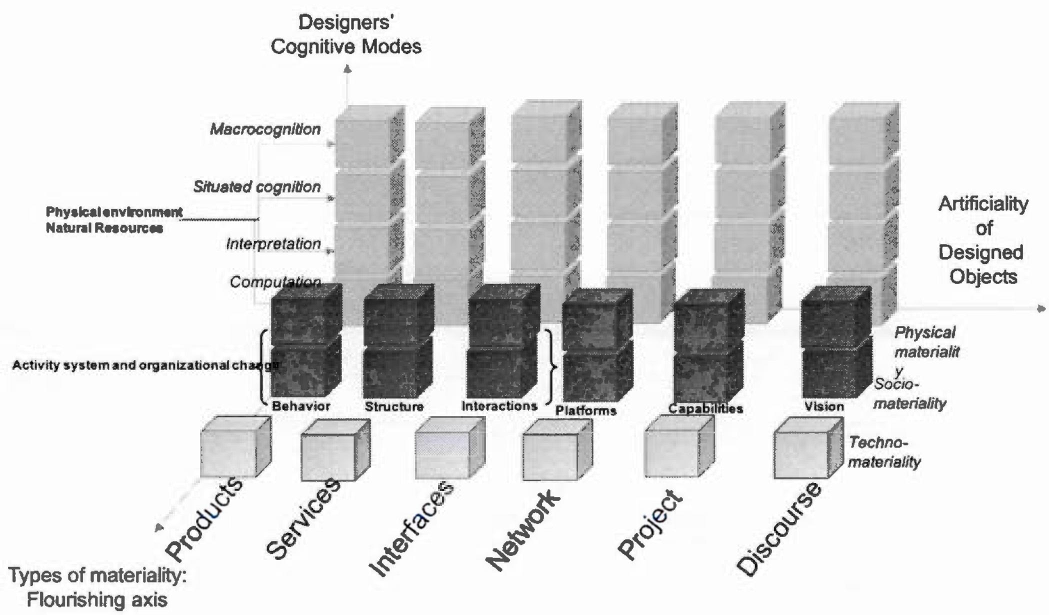


Figure 3.1 Cognition Intensity from Techno- to Socio- to Physical Materiality

BM designs for e.com ventures—before BMC was used—made BMs popular in the 90s' business world. This chapter takes a closer look at activity systems, one component of BMs. Then we examine how a business platform—that belongs to socio-materiality—is adequately described and modelled by OA from a strategic vision. By comparing OA and BM (BMC) design process requirements, this chapter opposes the BMC design stance (which is to find ideas that already fit into fixed categories) and the OA physical stance (which is to find a vision and build necessary knowledge to create the envisioned platform through three translations from vision to capabilities to platform). This opposition is illustrated by summarizing a problem-based learning experiment. The chapter ends by associating weak sustainability with thin design and strong sustainability with thick design and by synthetizing key elements such as cognitive processes, ontologies contributions and computer-based support in both BMC and OA approaches.

A lot of business design concepts, more or less connected with the MIS discipline, compete against each other through different tools, prescriptions and software. On one side, there is the influence and heritage of organizational design discipline (OD) (see Burton) as a managerial (soft) discipline, and, on the other side, there are approaches and methods like enterprise architecture (EA), enterprise architecture management (EAM) and a lot of (hard) hierarchical specialities from businesses and processes to technology and software architectures. Martin (2009) insists that 'design thinking' is present in all these approaches, and Lavin (2014) discusses the contradictions of these approaches on the field. In an MBA classroom, students had to use organizational modeling (OM) (Lejeune & Sack, 2011; Morabito et al., 1999), which is an organizational architecture (OA) approach—a thick design approach—allowing for soft architecture modelling (Table 3.1).

Table 3.1 Fine vs. Dense Design (Adapted from Sack, 2008)

Fine Design *(thin)* **Business Model Canvas (Hard)**	**Dense Design *(thick)*** **Organizational Architecture (Soft)**
Visible attributes	Hidden and essential character
Analysis and design as in engineering	Analysis and design as in anthropology
Scientific analysis	Phenomenon and experience
Formal and mechanical	Intuitive and reflective
Structural and modular	Cognitive and integral
Specify/specification	Relational and psychological specifications
Early knowledge binding	*Late knowledge binding*
Essentially explicit knowledge	Essentially tacit knowledge

3.2 Business Models: Techno-materiality and Thin Design

BMC developers wanted to improve design guidelines to help in the design process through computer-assisted design (CAD) software:

> Elaborating guidelines helps in the design of more coherent business models; in turn, this helps to improve the way in which CAD can support business model design. Nonetheless, all these advanced CAD tools, which are aimed at supporting the BMC, are worthless if they hinder the creative-thinking process enabled by the paper version. However, if evaluation can show that a digital canvas is perceived and performs at least as well as a paper-based canvas, this promises great potential. For example, some features, such as automated guidelines validation, are only possible with digital tools." (Fritscher & Pigneur, 2010)

3.2.1 BM Components: Thin and Hard Design

BMC displays nine predefined modules. Table 2.1 shows how modules correspond to fine design, while Figure 2.2 elaborates on the same:

- Visible attributes: These categories and attributes are explicit and visible. Culture and other invisible assets like knowledge are not modelled.
- Specify/specification: BM design is a specification effort that should be followed by an implementation effort.
- *Early knowledge binding*: As in the industrial era, complete knowledge is necessary before specification.
- Essentially explicit knowledge: Mobilized knowledge is shown on BMC modular structure.

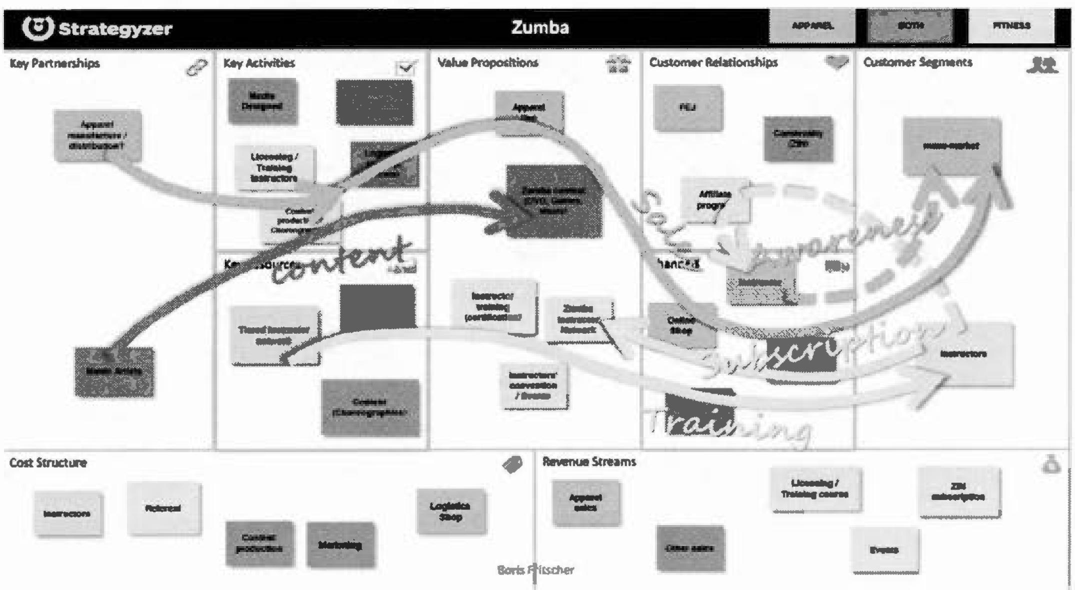


Figure 3.2 Using BMC for Zumba Case

Source: Fritscher & Pigneur, 2010

3.2.2 BM Success: Online Customer Interface and Thin Design

Having a BM was the right way to illustrate a dot.com case and compute a difference in costs and revenues. A BMC takes into account the customer interface, offerings, cost and revenue computation and activity system.

3.2.3 BMs as an Activity System

Zott and Amit (2010) essentially view a BM as an activity system; they describe it using two sets of parameters, design elements and design themes:

> Building on existing literature, we conceptualize a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries. The activity system enables the firm, in concert with its partners, to create value and also to appropriate a share of that value. Anchored on theoretical and empirical research, we suggest two sets of parameters that activity systems designers need to consider: design elements—content, structure and governance—that describe the architecture of an activity system; and design themes—novelty, lock-in, complementarities and efficiency—that describe the sources of the activity system's value creation. (Zott & Amit, 2010)

Visually, the Zott and Amit activity system model corresponds, in BMC, to some connected 'post-it' in the following categories: key activities, key partnerships and/or key resources.

3.3 Organizational Architecture: Socio-materiality and Thick Design

> The artefacts of thin design have been developed in the industrial and information eras and are well understood. Thick design is much more complex, and may require a refinement of OM constructs. This is an unexplored area of knowledge design, but it is here that radical change and improvement will take place. (Sack, 2008)

Our stance in this thesis is that OA, through its triple translation approach articulated from a vision, offers a way to design a business platform that can tailored to a specific business ecosystem, as innovators like Apple, Google, Amazon etc. have done successfully. At the end of an OA approach, there is a platform. That platform, suited to a business ecosystem, can be considered as a business model.

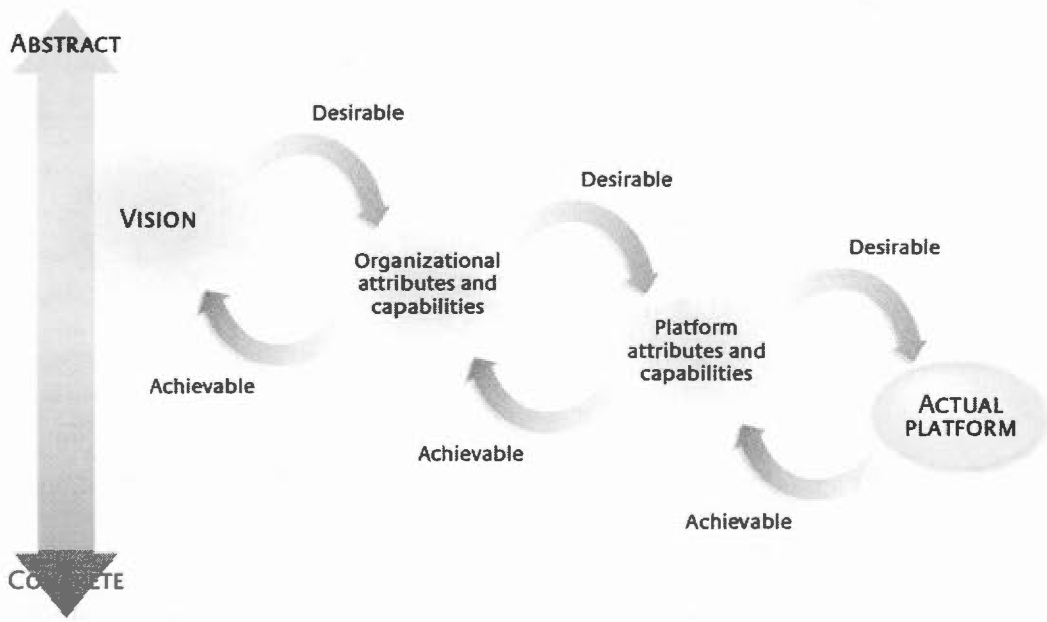


Figure 3.3 The Organizational Architecture (OA) Approach: From Abstract Vision to Concrete Platform

Source: Sauer & Willcocks (2002)

> The organizational architect follows a business vision through three translations, which first identify the required organizational capabilities and then define the platform that enables them. At each juncture, the architect explores trade-offs between what is desirable and what is achievable and clarifies the vision and its supporting technology, moving it from abstract (top

> of the vertical arrow) to concrete (bottom) at each translation point. Thus, the vision shapes the platform and the platform's capabilities keep the vision realistic. (Sauer & Willcocks, 2002: p. 44)

OA as a generic approach, and particularly OM as a language, are on the thick design side on Table 3.1.

Particularly close observation of thick design shows that:

- Organizational attributes and capabilities like agility and innovation culture are hidden and essential characters.
- Organizational analysis and design is closed to anthropology, i.e. to study an organizational culture.
- Moving back and forth from concrete to abstract imposes a cognitive and integral approach.

'Late knowledge binding' means that when the OA process begins at the vision stage, knowledge is not complete; continuous movement between vision, capabilities and platform will generate new knowledge through the comparison of what is desirable with what is achievable. Essentially tacit knowledge is mobilized during organizational design effort.

The electric car as a product may be a good case to illustrate the 'understanding' power of a traditional BM but also its limitations, as by Bohnsack et al. (2014) discussed regarding BM archetypes when exploring a BM evolution within the scope of an electric vehicle case. A company like Tesla that makes fully electric vehicles doesn't define itself as an automaker; Tesla doesn't want to build on existing automakers' BMs; Tesla doesn't have a BM in a classical sense. Tesla defines itself as an innovating energy company belonging to a vast worldwide business ecosystem where clean energy matters. Tesla batteries are designed for residential use as well as automotive use, while the founders of Tesla dream about making or about contributing to making an electric airplane.

So, Tesla does not have an upgraded or differentiated automaker BM, but Tesla has created something else: a flourishing business platform model (BMF) where culture and ecology values (absent in a BM), knowledge and innovation (absent in a BM) and leadership and will (absent in a BM) are key. Finally, Tesla doesn't share the auto industry's traditional boundaries[20] but is about to build a platform for clean energy storage and management regardless of what the final products or services may be. A platform is:

> An extremely valuable and powerful ecosystem that quickly and easily scales, morphs, and incorporates new features (called *planks* in this book), users, customers, vendors, and partners. Today, the most powerful platforms are rooted in equally powerful technologies-and their intelligent usage. In other words, they differ from traditional platforms in that *they are not predicated on physical assets, land, and natural resources*. (Simon, 2011: p. 7)

Thus, Tesla develops *planks* (i.e. long-life batteries, fast battery charging systems, electric vehicles, energy management systems, partners in the solar industry, etc.) for the clean energy business ecosystem through its platform. The Tesla platform can be seen as a business model (Tirole, 2016):

> *… the platform is becoming one of the most important business models of the new millennium-and with good reasons*. Buoyed by the success of Amazon, Apple, Facebook, and Google, many exiting new companies are hitching their wagons on the platform. In fact, the stated goal is: Become a platform, preferably a powerful one. Build a useful and complementary *plank*—that is, a product, service, or community that integrates with existing platform, or better yet, *platforms*. (Simon, 2011: p. 50-51)

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[20] The Economist, Technology Quarterly, December 6th-12th 2014: p.19-20.

Maybe Toyota is not lagging technologically with its new fuel-cell vehicle, the Mirai.[21] But the Mirai is still a product, not a platform!

Figure 3.6 illustrates differences between BM design using a BMC and platform design using OA. First, BM design fits with hard design, engineered and computed in techno-materiality. The activity system status is questionable. Is it reasonable to capture its complexity with a couple of Post-it notes not taking into account people, culture, learning, knowledge and organizational climate? With BMC, the activity system is approximated and can be lost in translation between socio-materiality and techno-materiality. In OA, particularly with the OM method used in the classroom, people do exist; they have competencies, and they develop learning abilities inside an organizational culture.

The vision in the OA approach shares a lot of commonalities with the 'backcast' approach in sustainability science mentioned in chapter one:

> /…/ the backcast approach starts with the current situation and a desirable future state based on defined parameters, then deduces possible future paths (Morioka et al. 2006). In backcasting, drivers changing trends are subjective, based on our will, not objective plausible scenarios. (Kajikawa, 2008: p. 232)

If, around 1995, BM design practices took off with fine design attributes, the study of knowledge creation in organizations and its management (KM) began at the same period to be an instantaneous success both in academia and in business, mainly with the dense design approach. An interpretation of what happened around 1995 is that the strategy concept as defined by Andrews (1971, 1981) fell into two parts: the first part in the virtual (empty) world with the BM (mainly developed by businessmen and managers) and the second part in physical (inhabited) world with KM, a new academic domain having its roots in philosophy and logic.

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[21] See http://www.businessweek.com/articles/2014-12-17/toyota-embraces-fuel-cell-cars-for-post-gasoline-future?campaign_id=DN121814.

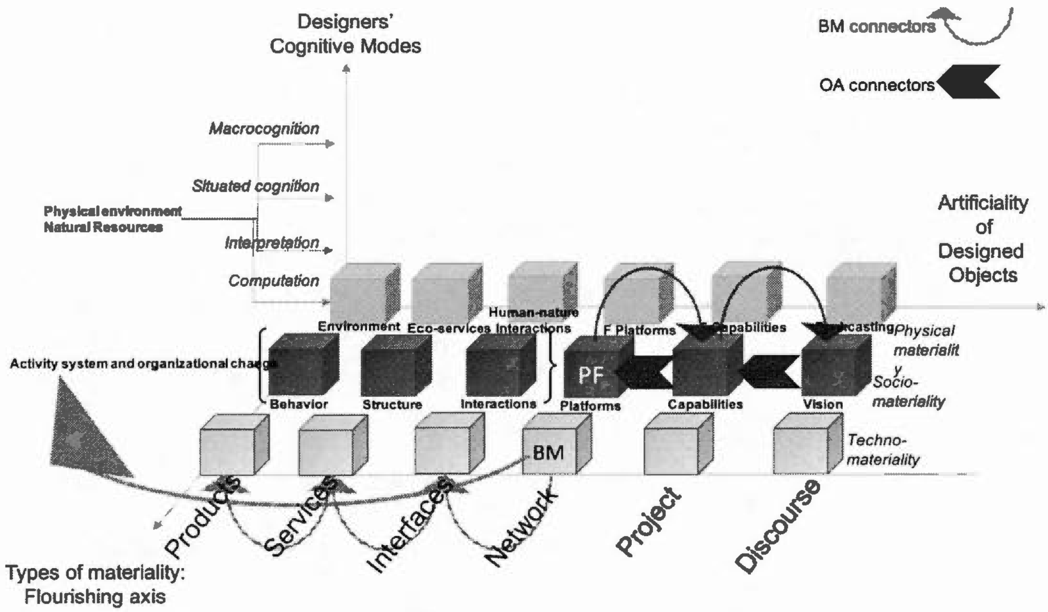

Figure 3.4 BM Design Approach Compared to OA Approach

BMs originated in products and services defined as business offerings. Alternative notions come from the design not of the products but of the organizations inside business ecosystems that develop key capabilities to make and sell the products (or the planks!), what we call the business platform model (BPM). Table 3.2 opposes products, services and identities designed for sale and to have social significance with organizational behavior generated by organizational domains like culture, people, process, information and learning. Finally, interfaces—following Krippendorff's (2007) view of the 'artificiality trajectory'—are paralleled with interactions between organizational domains and actors like organizational architects. Interfaces are a matter of interactive understanding of what artefact can afford (Krippendorff, 2007).

Table 3.2 Business Model (BM) vs. Business Platform Model (BPM)

Techno-materiality	Socio-materiality
Products "Products are the end products of processes of production, and equating artefacts with products limits product design to industrially manufactured artefacts." (Krippendorff, 2007)	**Behaviors** "The sources of competitive advantage are shifting to those organizational constructs that characterize the behavior of an organization: culture, people, process, information (data and knowledge), and learning (knowledge creation). It is these constructs that represent the core architecture of a 21st century organization." (Morabito et al., 1999)
Services "By contrast, [these] are artefacts that are designed for sales, to have social significance, or to create consumption." (Krippendorff, 2007: p. 19)	**Structures** "Historically, organizational design has meant changing structure. As other constructs came to the fore, the central position of structure remained essentially unchanged." (Morabito et al., 1999: p. 156)
Customer Interface "Interfaces are artefacts that reside between humans and machines including objects of nature. They consist of interactions, rudimentarily resembling human dialogue, not dead matter. Designing interfaces involves criteria that relate users' interactive understanding to what artefact can afford." (Krippendorff, 2007: p. 19)	**Interactions** "The business analyst must address many complex interactions: data and knowledge, organizational learning paradigms, culture change, business process change, integration, and even invention. Knowledge creation and learning, collaborative problem solving and team structures, new hardware and communication technologies, and the prevalence of knowledge workers have made the business analyst key in the design of the organization as a whole." (Morabito et al., 1999: p. 157)

BM as Market Device "(...) an intermediary between different innovation actors such as companies, financiers, research institutions, etc., i.e., actors who shape innovation networks. In their theory, such networks are created through what they call "narratives" and "calculations" which entrepreneurs circulate to describe their ventures and to construct markets. Here, the business model is seen as a reference point for communication among the different actors with whom entrepreneurs engage." (Boons & Lüdeke-Freund, 2013: p. 10)	**Platforms** "Fostering innovation and entry by the providers of complementary products may, in fact, require the platform manager to commit (by word or deed) not to provide certain complements. When the interface between the complementors and the platform is itself evolving, decision rules become ever more complex. The platform owner and the complementors might also need to consider whether the platform needs to be open or proprietary, and whether tools and other incentives should be provided to stimulate investment by the complementors." (Teece, 2007: p. 1332)(Teece, 2007: p. 1332)
BMI Projects Chesbrough (2010) offers some ways to overcome cognitive inertia: mapping, experimentation, effectuation and leading change. While mapping is the most exploited dimension in gamification, experimentation is efficient when "trying out an alternative business model on real customers paying real money in real economic transactions" (Chesbrough, 2010: p. 360). Effectuation and leading change are the second set of processes identified by Chesbrough (2010).	**Capabilities** "For analytical purposes, dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets." (Teece, 2007: p. 1319)
BM as Performative Discourse "We suggest that business models can be thought of as performative representations. A business model is a representation in that it is a text that redescribes and reconstructs reality—	**Vision** Savage (1990) refers to knowledging as "an active and continual process of interrelating patterns. It is more than the accumulation of and access to information, because it looks at both the

whether actual or imagined—in a way that is always partial, interested, and intent on persuading (Cock, 2000). Texts are more durable and intransitive than mere actions and therefore play an important role in infusing change (Phillips and al., 2004). A business model is performative in the sense that it engenders effects through reconstructing the social world in its own image (Callon, 2007)." (Perkmann & Spicer, 2010: p. 270)	known (information) and the visionary (what could be)." /.../ Thus, knowledging depends on people-for interpreting the known and for embodying the vision. /.../ Thus, knowledging is focused on learning, and is characterized by the content and process of knowledge creation, individual motivation, and the active involvement of the individual with his or her work. We refer to such a knowledging environment as a culture of engagement." (Morabito et al., 1999: p. 30)

3.4 Cognition Axis: Ways to Overcome Inertia

We are now discussing the hypothesis of higher cognition complexity and effort of techno- to socio- to physical materiality on the cognition axis. What are the cognition requirements for BM design with BMC? In this case, the categories are fixed, and what is needed is a stock of relevant initial knowledge that enables the generation of ideas to fill up BMC categories in an innovative way. Generally BM authors consider activity system business processes to be modeled with business process management (BPM) tools and software but they forget the classical Davenport opposition between 'process' and 'work' (Davenport, 2011). In OA, cognition means a need for continuous knowledge generation at different organizational levels, from strategic to operational, like in the SECI framework (Nonaka & Takeuchi, 1995). The OA world is a world of work and business practices distinct from business processes because practices are based on personal and social knowledge.

Anyone with business sense knows what to do with BMC categories like revenue, cost, product etc. History tells us that the Phoenicians—the merchant people who invented our alphabet—enabled the labelling of categories. Trade has left many traces in our language and culture. At the origin of our languages, all kinds of lists regarding cereal production, stocks, taxes, revenues etc. were drawn. Modern businessmen know what to do with income and expense categories; they can describe activities by identifying a system with its partners and define services and interface with customers. Making good use of these BMC categories, businessmen know whether their (actual or invented) BM creates value significantly and where costs and revenues are located. There are few or no learning issues—especially in a software environment where the rules of design are guiding the user. Interacting with BMC, businessmen take a 'design stance,' while calculations are performed by the computer. When checking the computed effects of variations in the content of categories, businessmen are under supervised learning. And what is going on in their head '*generates what they are capable of.*'[22]

After having studied one case extensively and autonomously in an inverted classroom, MBA students quickly complete BMC categories and build a BM. In practical terms, they act as real businessmen in performing BM mapping. As is the case for many businessmen, they may not be able to implement the BM, and what has happened in their heads is perhaps not unusual enough to generate outstanding achievements. So BMC mapping would fit with the following Kahneman (2003) statement: "People are not accustomed to thinking hard and are often content to trust a plausible judgment that comes to mind."[23] In that vein, Chesbrough (2010) defines

[22] Harnad, S. Notes ISC1000, Winter 2015.

[23] Kahneman, D. American Economic Review 93 (5) December 2003, p. 1450.

cognitive inertia around BM innovation (BMI) and limitations on creativity. BM idea mapping is built through trial and error through supervised learning thanks to the calculation of added value. Trial and error generates the need for multiple ideas to be tested, hence the importance and pertinence of gamestorming discussed later in this chapter.

Chesbrough (2010) offers three ways other than mapping to overcome cognitive inertia: experimentation, effectuation and leading change. While *mapping* is the most exploited practice in BMI, *experimentation* is efficient when '*trying out an alternative business model on real customers paying real money in real economic transactions*' (Chesbrough, 2010: p. 360). Many tools are available to managers wishing to experiment (T. Davenport, 2009). *Effectuation* is the second set of processes identified by Chesbrough (2010). In this case, there is a strong bias for action over analysis, because there may be insufficient data available to analyse a way toward a new business model (Chesbrough, 2010: p. 361). Effectuation processes are thus actions '*critical for the cognitive act of reframing the dominant logic of one's business model*' (p. 361). Figure 3.7 shows that a BM lies at the center of a 2x2 matrix opposing problem definition on one X axis and kinds of knowledge on the Y axis. The strategic performance level is the level of the BM as scenario/test/experiment or change agent; the design level is the level where a BM is designed as a canvas or a pattern.

On the X axis (see Figure 3.7), there is a continuum between the business model and the theory of business much in the same way models and theories are connected in social research. Following the definitions of Van de Ven (2007), models are partial representations of theories, but they do not simply represent operational versions of a theory (p. 143). They serve as mediators between theories and data, or between theory and the world. Paraphrasing Van de Ven (2007), a research model—like a business model—is an instrument for linking theory with data in terms of function, representation and learning. Data generated by experimentation can be a source of BM discovery. Following Teece (2010: p. 173), a BM, if it is not a spreadsheet or computer model, "might well become embedded in a business plan and in income statements and cash flow projections. But, clearly, the notion refers in the first instance to a conceptual, rather than a financial, model of a business." For Teece (2010), a BM is nothing less than a business' organizational and financial 'architecture.'

Figure 3.7 integrates BM literature with business model innovation (BMI) literature to better illustrate the four ways to overcome cognitive inertia. In the figure, each of the four directions is pointing to a specific business context between data manipulation and theory of the business definition.

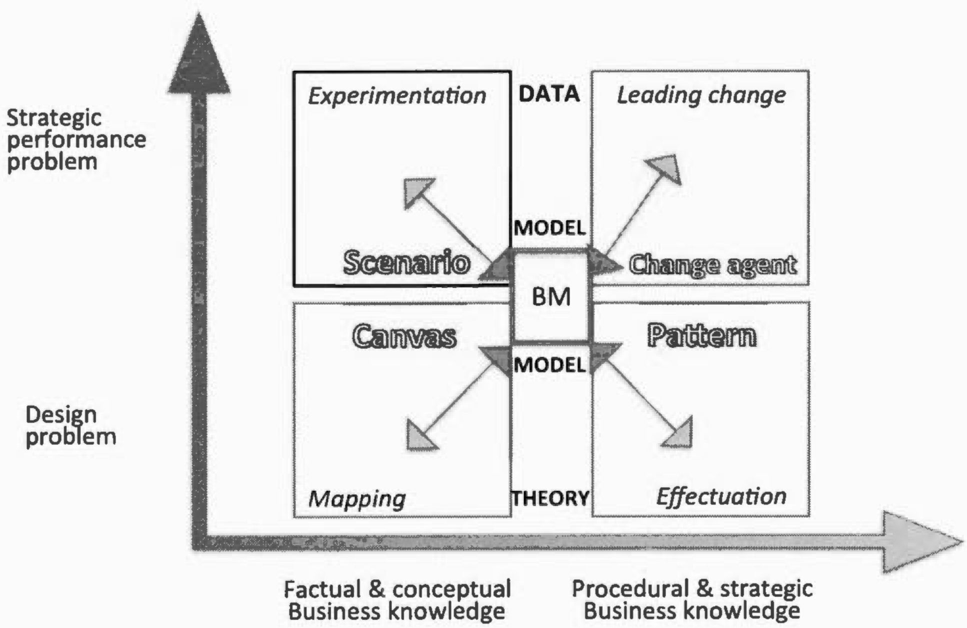

Figure 3.5 Four Contexts and Four Ways to Generate a Business Model

3.4.1 Mapping

Business Model Generation is the title of a popular book written by Osterwalder and Pigneur (2010). Written with business managers in mind, the book offers a process to build a complete BM by using the canvas illustrated in Figure 3.2. The book has five sections: Canvas (a tool for describing, analyzing and designing business models), Patterns (based on concepts by leading business thinkers), Design (techniques to help design business models), Strategy (re-interpreting strategy through the BM lens), Process (a generic process to help design innovative business models) and Outlook (a last section on five business model topics for future exploration). This popular book (more than 1,000,000 copies sold) demonstrates the authors' mastery of BMI mapping.

3.4.2 Experimentation

Recent literature, and particularly "How to Design Smart Business Experiments" by Davenport (2009), emphasizes well-targeted and structured experiments while being consistent with the scientific method of hypothesis testing. According to Davenport (2009), these business experiments become a new way of organizing research and development to start a new business, to innovate in terms of products or services or to modify any business process in a company. But where are the assumptions underlying these experiences? It is likely that proposals are emerging from different groups (quality circle, teamwork, project team, community of practice, focus group, etc.). These proposals have been sorted, screened and ordered presumably with the help of intrapreneurs (in large organizations) or directly by the head manager, and, particularly in the case of a new start-up, requires and imposes rapid cycles of hypothesis testing. Drucker (1994) believes that firms that vary, extend, multiply and overlap context hypothesis testing and business experiences are better able to anticipate the environment of the firm. Tactical issues of business hypothesis are highly strategic issues. For Brynjolfsson and Schrage (2009), these experiences are both more prevalent and critical given the increasing potential of information technology (IT).

3.4.3 Effectuation

Chesbrough (2010) puts emphasis on Sara S. Sarasvathy, who wrote the last thesis directed by Herbert Simon. The book derived from her thesis is entitled: *Effectuation: Elements of Entrepreneurial Expertise*. She defines effectuation as the logic of entrepreneurial expertise: "By logic, I mean an internally consistent set of ideas that forms a clear basis for action upon the world. A causal logic is based on the premise: To the extent we can predict the future, we can control it. An effectual logic is based on the premise: "To the extent we can control the future, we do not need to predict it." For Sarasvathy (2008: p. 17), effectuators see the world as open, still in-the-making.

3.4.4 Leading Change

> Against a backdrop of increasing globalisation, deregulation, the rapid pace of technological innovation, a growing knowledge workforce, and shifting social and demographic trends, few would dispute that the primary task of management today is the leadership of organisational change (Jackson, 1997; Stace and Dunphy, 1996; Kanter et al., 1992; Limerick and Cunnington, 1993; Naisbitt and Aburdene, 1990; Ulrich and Wiersema, 1989). (Graetz, 2000: p. 550)

This can be illustrated by Paul Polman, Unilever CEO, who says:[24]

> Most businesses operate and say how can I use society and the environment to be successful? We are saying the opposite—how can we contribute to the society and the environment to be successful? For me, this is the difference between the standard business case for sustainability—doing the right thing if it is profitable, and the leadership business case—making the right thing profitable. This distinction is crucial, as it shows that a business has considered the profound implications of big sustainability challenges on the business, and has a plan to respond to these challenges in a way that works for the business and the world around it. Unilever, and others, recognize the interdependence of a business and the system around it. So, the first step towards succeeding with sustainability is to ask the right question. Not how can I make my business sustainable, but how can I make our world sustainable?

3.5 Problem-Based Learning Experiment

The ideas exposed in this chapter result from an Executive MBA course entitled "Organizational Dynamics and Organizational Architecture" given to 22 managers from different industries. The main goal of the course was to make a diagnosis and then model a solution for a company producing electricity mainly from coal and nuclear energy.

Project-based learning environments have five key features. Following Krajcik and Blumenfeld's (2006) criteria, the course has a driving question—situated inquiry—and engages students in collaborative activities; students are scaffolded with learning technologies like G+ Community, Google Docs, MindMup, Hangout and must create a set of tangible products using Wikispaces.

[24]https://www.forumforthefuture.org/blog/6-ways-unilever-has-achieved-success-through-sustainability-and-how-your-business-can-too

The Ivey Case number 910E02 (Raghu, 2010)[25] on Pinnacle West (PW) describes a company in the U.S. energy sector experimenting actual process management problems and future uncertainty in a world where the smart grid concept pushes energy companies to become the new 'Google of Energy.' The physical environment is not explicitly problematized even in the case where PW essentially operates a nuclear reactor and coal generated electricity. Managerial questions at the end of the case pointed to business process management and a smart grid. The driving question is, first, how to fix processes quality problems, and, second, how to become a smart grid player?

The course designer asks students to be part of two of the four teams that will be working on problem definition and resolution (one team working on the diagnosis and three teams working through potential solutions). The idea behind team formation is not to establish competing teams but to install a climate of cooperation, with all teams working together to design a common yet unique solution. During the session, one team exploited an architecture modelling approach (OM for organizational modeling) to produce a state of the extant business processes, an 'as-is' situation formalized with OM concepts and syntax. Three other teams worked: 1) on innovation, culture and technological platform support (learning from the 'C2' platform developed by COGNIZANT (Harvard Business School Case #410084[26]), 2)

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[25] Raghu, 2010

[26] Eccles & Davenport (2010). COGNIZANT 2.0: Embedding Community and Knowledge Into Work Processes. HBSP.

on knowledge management applied to manufacturing industries (applying the AKM[27] approach and practices), and 3) on the infrastructure of the ICT business ecosystem (Fransman, 2010).

During the session, MBA students followed a knowledge-building approach (DMO developed by Lejeune and Lemire; see DMO2013 on Wikispaces: http://dmo2013.wikispaces.com) that guided them through lists, conceptual networks and concentric maps (Figure 3.8) with the goal of proposing scenarios to fix actual PW problems and envisioning a new platform around the smart grid concept (Scardamalia & Bereiter, 2006).

The theoretical part of the course given by the professor explained the 'organizational architect three translations' model and commented on the contributions of different approaches like OM and AKM.
Moreover, students were introduced to four types of knowledge as defined—in the Bloom tradition—(Anderson and al.,2001: p. 29)

[27] Lillehagen, F., & Krogstie, J. (2008). Active knowledge modeling of enterprises. Springer Science & Business Media.

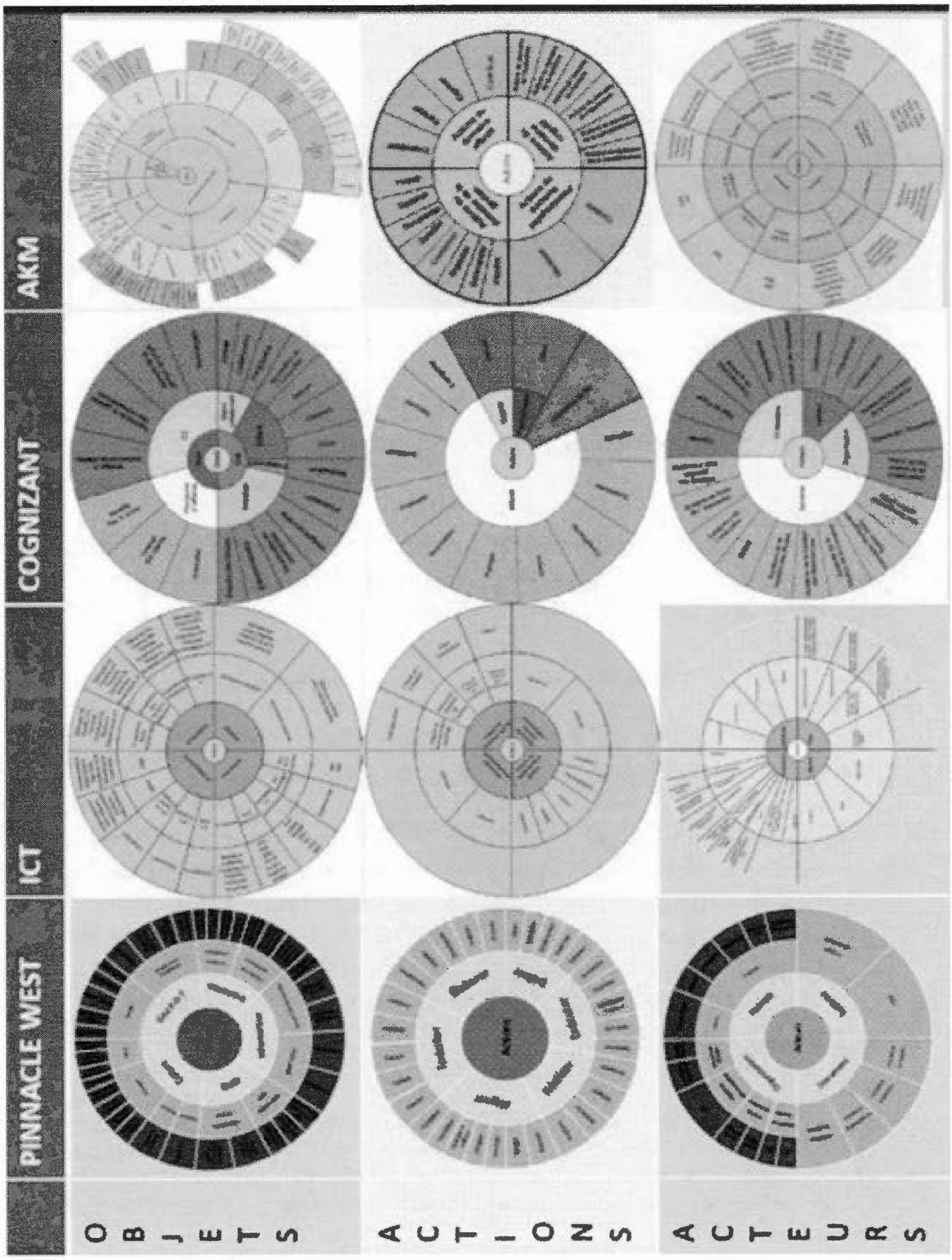

Figure 3.6 Four Teams' Concentric Maps: Actions, and Objects (in French)

- Factual knowledge:

The basic elements students must know to be acquainted with a discipline or solve a problem (Also: knowledge of terminology, knowledge of specific details and elements).

- Conceptual knowledge:

The interrelationships betweem the basic elements within a larger structure that enable them to function together (Also: knowledge of classifications and categories, knowledge of principles and generalizations, knowledge of theories, models and structures).

- Procedural knowledge:

How to do something, methods of inquiry and criteria for using skills, algorithms, techniques and methods (Also: knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, knowledge of criteria for determining when to use appropriate procedures).

- Metacognitive knowledge:

Knowledge of cognition in general as well as awareness and knowledge of one's own cognition (Also: strategic knowledge, knowledge about cognitive tasks, including appropriate contextual and conditional; knowledge, self-knowledge).

All knowledge is represented using the DMO approach.[28] DMO belongs to social constructivism:

> Russian psychologist Lev Vygotsky, regarded as the father of social constructivism, believed that knowledge was constructed through dialogue and interaction with others (Vygotsky, 1978). He argued that knowledge is co-constructed in a social environment and that in the process of social interaction, people use language as a tool to construct meaning. The use of language between individuals in an environment as an interpsychological tool is central to social constructivist thought on the learning process. Successful learning is said to result in an internal dialogue as an intrapsychological tool that can be used in the future across varying situations (Marsh & Ketterer, 2005; Vygotsky,

28 DMO is being developed by Lejeune & Lemire as a disciplined approach to organize knowledge that reflects a deep understanding of the subject matter and affects how students learn and represent problems. By using DMO, both teacher and students are connecting problem-solving and knowledge-construction processes in a visualization-based learning environment as proposed by Wang, Wu, Chen, Spector and others (2013).

> 1978). This scaffolding can be stored in memory and used by the learner to make sense of his or her environment at a later date. (Churcher et al., 2014: p. 35)

3.6 Building or Playing with Categories: Ontology Building vs. Gamestorming

Gray et al. (2010) give Osterwalder and Pigneur's (2010) BM book on Business Model Generation the label of gamestorming application. Contrary to the serious games approach, gamestorming is an approach dedicated to the design of simple games (i.e. no computer needed) that can be played by several people during a meeting to explore and experiment with solutions to complex problems:

> In knowledge work we need our goals to be fuzzy. Gamestrorming is an alternative to the traditional business process. In gamestorming, goals are not precise, and so the way we approach the challenge space cannot be designed in advance, nor can it be fully predicted. While a business process creates a solid, secure chain of cause and effect, gamestorming creates something different: not a chain, but a framework for exploration, experimentation, and trial and error. The path to the goal is not clear, and the goal may in fact change. (Gray et al., 2010: p. 5)

Gray et al. (2010) explicitly associate gamestorming with supervised learning through exploration and trial and error or playing with categories instead of building them. It is true that BMCs equate to a framework for exploration, experimentation, and trial and error. But the challenge space is—contrary what Gray et al. suggest—truly designed in advance, 'gamers' having to develop strategies to connect nine fixed components resulting from formal ontology development.

3.6.1 Formal Ontologies, Canvases and Change Strategies

Gruber (1993) defines a formal ontology as a "specification of a conceptualization."[29] Three methods are generally possible to construct an ontology: the manual method, the automatic method and the mixed method. The manual method allows experts to define, in a consensual way, concepts and links that connect them per their view of the domain. The technique is particularly useful for creating a new ontology or expanding on an existing ontology. For the automatic method, ontology is built by computerized knowledge extraction techniques. The concepts and relationships of a specific domain are extracted and verified by computer-assisted inferences. The hybrid approach combines the first two methods so that ontologies are first developed by automatic inference software, then verified and extended manually. Domain ontologies have been emerging over the last ten years in three fields connected with BM design and sustainability. They are now ontologies in sustainability science, organizational architecture and BM design.

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[29] "What is important is what an ontology is for. My colleagues and I have been designing ontologies for the purpose of enabling knowledge sharing and reuse. In that context, an ontology is a specification used for making ontological commitments. The formal definition of ontological commitment is given below. For pragmatic reasons, we choose to write an ontology as a set of definitions of formal vocabulary. Although this isn't the only way to specify a conceptualization, it has some nice properties for knowledge sharing among AI software (e.g., semantics independent of reader and context). Practically, an ontological commitment is an agreement to use a vocabulary (i.e., ask queries and make assertions) in a way that is consistent (but not complete) with respect to the theory specified by an ontology. We build agents that commit to ontologies. We design ontologies so we can share knowledge with and among these agents." See Tom Gruber, http://www-ksl.stanford.edu/kst/what-is-an-ontology.html

3.6.1.1 In the Sustainability Science Domain

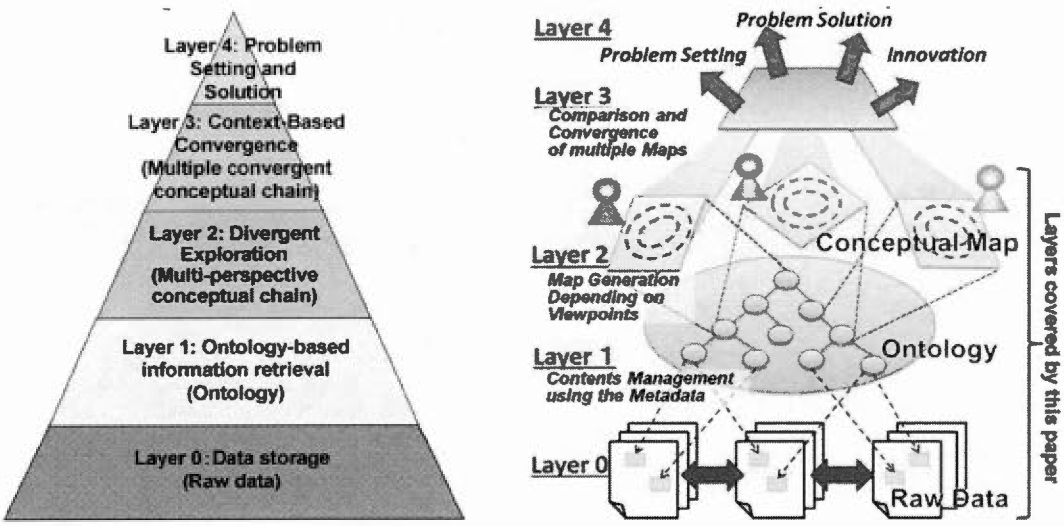

Figure 3.7 Sustainability Science Ontology

Source: Kumazawa et al. (2009)

The requirements can be described from two perspectives; one related to the knowledge architecture itself and the other concerning the functions required to support users. The first perspective can be examined from three subperspectives: 'whenever,' 'whatever,' and 'whoever.' By 'whenever,' we mean that structured knowledge should be reusable. Thus, reusability is one of the requirements for SS knowledge structuring. 'Whatever' implies that structured knowledge should be applicable to as many different domains as possible, not just to a specific domain or discipline, due to the multidisciplinary and interdisciplinary characteristics inherent to SS. (Komiyama & Takeuchi, 2006)

3.6.1.2 In the Organizational Architecture Domain

> Ideally, the enterprise conceptual model should be an ontological model [6]. An enterprise ontology should provide a coherent reference model establishing a common conceptualization on enterprises. This common conceptualization can be used to ensure that all parties involved (inside an enterprise and across enterprises) have a shared understanding of the relevant aspects and abstractions of the enterprise [23, 26]. (Falbo *et al.*, 2014)

Table 3.3 The Four Pillars of Osterwalder's Ontology (2004)

Pillar	Building Block of Business Model	Description
Product	**Value Proposition**	A Value Proposition is an overall view of a company's bundle of products and services that are of value to the customer.
Customer Interface	**Target Customer**	The Target Customer is a segment of customers a company wants to offer value to.
	Distribution Channel	A Distribution Channel is a means of getting in touch with the customer.
	Relationship	The Relationship describes the kind of link a company establishes between itself and the customer.
Infrastructure Management	**Value Configuration**	The Value Configuration describes the arrangement of activities and resources that are necessary to create value for the customer.
	Capability	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer.
	Partnership	A Partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer.
Financial Aspects	**Cost Structure**	The Cost Structure is the representation in money of all the means employed in the business model.
	Revenue Model	The Revenue Model describes the way a company makes money through a variety of revenue flows.

Source: Osterwalder, 2004: p. 43

3.6.1.3 In the Business Model Domain

Under ontological modelling a rigorous approach to defining business models is meant. In other words, this means carefully and precisely defining business model terms, concepts, components and their relationships. From the authors analyzed in this literature review, Gordijn (2002) provides the most rigorous conceptual modeling approach, which he calls e3-value™. This methodology is based on a generic value-oriented ontology specifying what is in an e-business model. On the one hand, it has the goal of improving communication and decision-making related to e-business, and, on the other hand, it aims at enhancing and sharpening the understanding of e-business operations and requirements through scenario analysis and quantification (cf. 3.1.5). e3-value consists of a number of generic concepts and relationships illustrated in Figure 19. Gordijn specifies actors that produce, distribute or consume objects of value by performing value activities. The objects of value are exchanged via value interfaces of actors or activities. Value interfaces have value ports offering or requesting objects of value. The trade of value objects is represented by value exchanges, which interconnect value ports of actors or value interfaces. (Osterwalder, 2004: p. 35-36)

> In this dissertation I pick up the idea of building a business ontology aiming at improving understanding, communication and flexibility just as do the Enterprise Ontology and the Toronto Virtual Enterprise. But while these overall objectives might seem quite similar, the domain and content of the ontology delivered in the following chapters of this dissertation is substantially different. While the Enterprise Ontology and the Toronto Virtual Enterprise focus essentially on structural aspects of business I aim at formalizing business concepts in the business model domain." (Osterwalder, 2004: p. 41).

3.6.1.4 Hypothesis about the Contribution of Formal Ontologies to BMF

Imagine three networked formal ontologies: one for BMs (BMO), one for SS (SSO) and one for OA (OAO). There could be a partial automated 'solution' found to 'green' a BM, but it will still mean weak sustainability for three reasons: actors stay in a design stance, have no access to physical space and leave consciousness out. Ehrenfeld (2014) again underlines that the primary role of business is to enable people to flourish—that is, take care of the world around them:

> This concept of sustainability as the creation and maintenance of flourishing would require the corporate world to think of its businesses in a fundamentally different way. In this model of economic interactions, business's primary role would be to enable people to flourish — that is, take care of the world around them. Such a world would be very different from what we see today. Eco-efficiency and CSR would still be on the agenda, but the creation of flourishing would come first. It's obvious this would require radical change. Corporations' basic strategies would move from satisfying needs (or wants) to enabling care. Sustainability practices as understood today would still be important for managers, but would be completely intertwined with and inseparable from whatever basic strategy is driving a firm. There would be no more specialized sustainability surveys, such as the current *MIT SMR*/BCG report; only composite assessments of contributions to flourishing. While profit would continue to be important to a firm's success, it would take a backseat to the firm's contribution to flourishing.[30]

3.6.2 Informal Ontologies: When Communities of Knowledge are Ontologizing

Our hypothesis is that the manual knowledge building process is essential to propose a physical, implementation-oriented stance, with formal ontologies limiting decision

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[30] http://sloanreview.mit.edu/article/sustainability-redefined-setting-a-goal-of-a-flourishing-world/

makers in a design stance. Following Ehrenfeld, sustainability is a people experience and an ontologizing approach that capitalizes on people's experiences. The DMO ontologizing approach (Lejeune & Lemire, 2013)[31] includes seven main stages. Presented in a sequence, the process may change iteratively; generated concept maps (Figure 2.6) are the pre-stage creation of a formal ontology:

> 1) Collect data. Each researcher involved in a project modeling team enters the domain by referring to his knowledge, then to the literature, or by interviewing practitioners. Together the team collects important concepts and constructs that describe the knowledge domain under study.
>
> 2) List terms: A workgroup produces a common list of the important terms discovered in the previous step. It is always useful to order the list in alphabetical order to detect built redundancy.
>
> 3) Organize concept clusters. This activity involves manipulating and grouping terms from the list. During this step links, or relationships between these terms, are established. At this stage of the process, the focus is on two types of relationships: meronimic relationships (usually an object belongs to another (A part of B)) and hyponimic relationships (inclusion or inheritance relationships between two objects (A is B).
>
> 4) Design a graph: This task is assisted by a knowledge modeling tool (e.g. CMap, Thinkgraph, Mindmanager etc.) from the preceding step. Such tools facilitate the manipulation of terms, especially when their number increases. This phase is an opportunity to define more precisely the knowledge domain, to refine the relationships and look for missing information.
>
> 5) Concentric maps: Once a consensus is reached, the graph structure is reproduced as concentric maps. A concentric map consists of a center and several rings. The circle that defines the center is called the nucleus; it contains the basic term used to identify the knowledge domain or the world under study. From the nucleus other terms are deployed in multiple rings. Each ring has sub-concepts or sub-domains under the main concept. Concentric maps have the

[31] Lejeune & Lemire, 2013 (http://dmo2013.wikispaces.com/Accueil)

> advantage of providing an overall view and delineate a knowledge domain while implicitly showing the hierarchical structure of categories (concepts). These representations also show that it is possible to organize a large amount of information into a coherent and easily accessible map set. The realization of concentric maps usually requires process flow software like Visio.
>
> 6) Develop the glossary and the index: This glossary is background knowledge. It has as main function to make uniform the knowledge of categories available to the different teams. The use of glossaries is especially useful when used in work activities shared within a team working on the same project or on distributed learning approaches (Lemire and Harvey, 2002). Each glossary entry contains the built definitions, descriptors, related words and words equivalent in other languages, if any. Then follows the index. The index facilitates identification of lexical items. This involves classifying categories in an alphabetical table that refer to pages and resources used.
>
> 7) Scenarios building: Each team produces ten scenarios from actors, actions and objects maps. For example, the PW team must build a vision for the future by defining aspirations like:

Scenario 3: (Actor) Consumers—(Action) To sell—(Object) Renewable energy—(Actors) Energy Producers

Governments subsidize increasing selling prices (kWh) of renewable energy; households have installed solar panels on the roofs of their houses. This approach is open to every generic actor defined in OM (Morabito et al, 1999): human, organizational, system, document. DMO is a way of eliciting and sharing knowledge, and may act as a driver for macrocognition and consciousness:

> Consciousness begins when brains acquire the simple power of telling a story without words using a nonverbal vocabulary of body signals about the living organism constantly altered by internal and external adjustments of the life process. The self appears then as the feeling of a feeling. Knowledge of those feelings emerge as a response to a question never asked. (Damasio, 1999: p. 30-31)

> Consciousness is, in effect, the key to a life examined [...] At its simplest and most basic level, consciousness lets us recognize an irresistible urge to stay alive and develop a concern for the self. At its most complex and elaborate level, consciousness helps us develop a concern for other selves and improve the art of life.[32] (Damasio, 1999: p. 5)

3.7 Conclusion: BMFs as Simple Canvas or Complex Organizational Architecture?

Stubbs & Cocklin (2008) open doors to a new BM representation at the business ecosystem scale (Figure 2.7. D). Per Bocken et al. (2014):

> While there is extensive literature on the theory of business models for delivering sustainability (e.g. Stubbs and Cocklin, 2008 conducted a literature review), and examples on specific companies (e.g. Xerox, Canon and Océ 'pay per copy' models, Baines et al., 2007) there is no comprehensive view of how firms should approach embedding sustainability in their business models.

Stubbs and Cocklin (2008) redefines BM by bringing in nature as a main stakeholder and pushing for physical materiality and strong sustainability, a concept closer to a flourishing business future. Together, they bring new inspiration to emerging BMF domain. They don't focus first on value-adding activities but on internal organizational capabilities to be generated in a given socioeconomic environment, with natural, structural and cultural attributes.

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[32] Damasio, Antonio. 1999. The Feeling of What Happens: Body and Emotion in the Making of Consciousness. New York: Harcourt Brace & Company.

From http://oceanflynn.wordpress.com/2007/04/21/how-can-i-tell-what-i-think-until-i-see-what-i-say/, December 6, 2014

3.7.1 Weak and Strong Sustainability

Like Roome (2012) in strategic management, Nilsen (2010a,b) in economics makes the distinction between weak and strong sustainability. For Nilsen (2010b):

> Weak sustainable development (Weak) is characterized by the goal to sustain a constant level of consumption or utility. *To achieve this goal, nature and capital goods can be substituted with each other.* Neither nature nor capital has an intrinsic value, but is an instrumental value to achieve the highest possible level of utility. *Weak is often called 'Solow-Hartwick sustainability'* as it is based on the work of Nobel Prize winner Solow and Hartwick (Neumayer, 2003, p. 22). *A main challenge is to calculate how big the compensation in capital must be for the loss of natural goods.* This is the idea in cost-benefit analysis, a main tool in neoclassical economics also used in environmentally sensitive issues (Pearce & Turner, 1990). Weak belongs to neoclassical economics, which has dominated the sphere of economics: 'Most, but not all, economists are weak sustainabilitists.' (Perman, Ma, McGilvray, & Common, 2003: p. 91). (Emphasis added)

Weak sustainability is connected with organizational computation by a main challenge: the challenge to *calculate* how big the compensation in capital must be for the loss of natural goods. This challenge can also be linked to GRI reporting practices. Efforts of environmental activists and committed policy makers led to the creation of the GRI *(Global Reporting Initiative),* a non-profit organization based in Amsterdam since 1997 and created by CERES, the *Coalition for Environmentally Responsible Economies,* an NGO based in Boston and a central actor in the integration of environmental issues into business activities. The guidelines GRI developed for sustainability reporting have over the years become a standard for triple reporting: financial, environmental and social. Some companies have begun to publish separate environmental reports as a complement to their annual report. Between 1989 and 1993, 70 companies published environmental reports compared to 300–400 in 1996 (Etzion & Ferraro, 2010). It is interesting to note that, with Etzion and Ferraro (2010), it is by analogy with the rules for filing a financial statement that the guidelines have expanded the GRI. In terms of observable organizational *pattern*

(Morabito *et al.*, 1999), sustainability reporting is an informational pattern that differs from both its apparent high representation—its materiality—and its rapid rate of crystallization. But a company can issue sustainability reports without being transformed by new 'green' cultural values. Changes in the informational pattern are faster and more visible than cultural changes. But all the changes—and consistent alignment over time—depend on the culture, both the national culture and its expression in the organizational culture.

Nilsen (2010) continues:

> A less common, but increasingly more used theoretical concept is strong sustainable development (Strong) (Nielsen, 2008,p. 114) . *Strong requires that there must be a restriction on the substitution between the economy and nature, both must be sustained.* The restriction on substitution clearly pulls sustainability away from Weak and its homogenous focus on human development, in the direction of encompassing ecological values. Strong has a heterogeneous foundation which makes the qualitative different values of economy and ecology possible. (Emphasis added)

From an organizational cognition point of view, strong sustainability requires qualitative interpretation of different values in economy and ecology. But following Byrch et al. (2007:p. 28), the usual sustainability challenge centers on weak sustainability:

> "Despite the debate over its meaning, sustainable development, and the related concept of sustainability, would seem to have more proponents than ever. Many individuals and organisations—in particular government and business organisations—are taking up the "sustainability challenge" and incorporating their own understanding of sustainable development into various aspects of their operations. In simple terms, the definitions adopted and their respective interpretations demonstrate the relative emphasis given to environmental, social, and economic domains by different groups, and how the concepts of equity, fairness and futurity are applied to those domains."

On the other hand, again for Byrch et al. (2007:p. 28), strong sustainability will require an 'ecocentric' worldview instead of technocentric or anthropocentric worldviews:

> There is a substantial body of literature that suggests that these varying emphases in turn reflect individuals' fundamental beliefs about humanity's proper relationship with nature; that is, their environmental "worldview." Environmental worldviews which are more biocentric are said to lead to significant sustainable environmental performance—although more research is needed to sustain a clear link as worldviews do not always translate into actions consistent with those underlying beliefs.

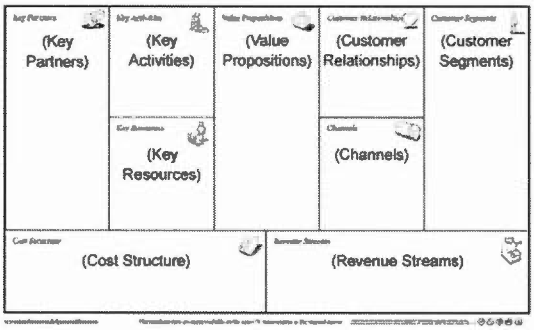
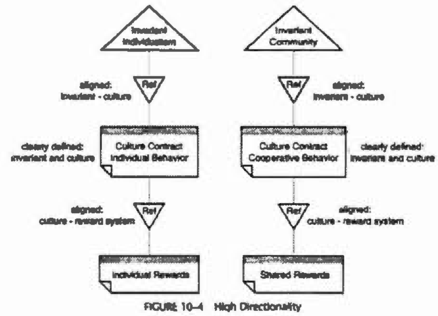
Figure 2.7. shows a parallel between BMs for sustainability (BMSs) built on BMC (Osterwalder, 2004) foundations, and our BMF vision that borrows from OA aims at integrating nature in the model. The main difference between BMSs and BMFs is in their ontology content. In their respective process, both are top-down approaches offering an ontology concentrated in a more or less simple framework to guide designers in their BM choices. But Osterwalder's (2004) template is not designed with sustainability in mind. However, it is often the first framework used by students or managers juggling 'green' ideas around a BM (Figure 2.7 C). As shown by an experiment with professional managers, each case or category inside the template can be 'greened.' What is lacking in this case is a holistic and coherent approach or method to insert sustainability inside a BM. An FBM is more complex and tries to connect with the changing strong sustainability–flourishing movement.

In the BMS case, the SSBMG group from Toronto is still developing a more complex framework, mixing the nine value categories with physical environment and nature elements canvas. They renamed their BM canvas for strong sustainability a canvas for flourishing: is this a marketing strategy? The SSBMG group canvas is well documented through its LinkedIn group, a blog, a wiki, and a website (http://www.ssbmg.com). Their announced research streams are:

- [T]o assist and accelerate the shift of Small and Medium Enterprises (SMEs) at any stage of development (from start-up to long lived) to a strongly sustainable mode of operations. To achieve our objectives our research and practice agenda is organized along a number of 'streams':
- Human-centric research about how leaders in SMEs actually make decisions and what role, if any, business models play in this context.
- To develop and validate an ontology for strongly sustainable business models and a visual tool for modeling such businesses (the SSBM Canvas)
- To explore advanced methods of impact definition, measurement and valuation of social and environmental benefits that can support decision-making in organizations, particularly in the context of business models.
- To identify and map the processes related to business strategy decisions in SMEs. Use design methods to develop a toolkit for SMEs and test the kit with organizations to further improve it and to create case studies.

3.7.2 Paralleling Weak and Strong Sustainability with Thin and Thick Design

In the case of a BMS designed with the SSBMG approach, students and managers will broach a brainstorming (or 'gamestorming') task that focuses on value; this is a more or less complex task because of the sustainability objectives and constraints. The Toronto SSBMG built a strongly sustainable BM design canvas by asking five questions for a business 'to do well,' inspired by texts written by Paul Guilding; they used Osterwalder's canvas to ask nine questions for a business 'to do well.' A total of 14 questions should guide the definition of imperatives. Surprisingly, neither sustainability science nor sustainability ontologies like those developed in Japan were used by SSBMG group. Constrained by BMC, BMSs such as the Toronto SSBMG have built a narrow learning corridor. Fixed BM categories are defining the borders, while effects on the environment are the obstacles (Figure 2.8).

<table>
<tr><th>Business Model for Sustainability</th><th>Business Model for Flourishing Business</th></tr>
<tr><td>A
</td><td>B
</td></tr>
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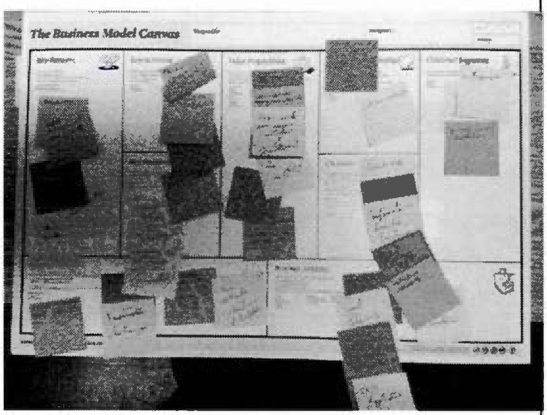
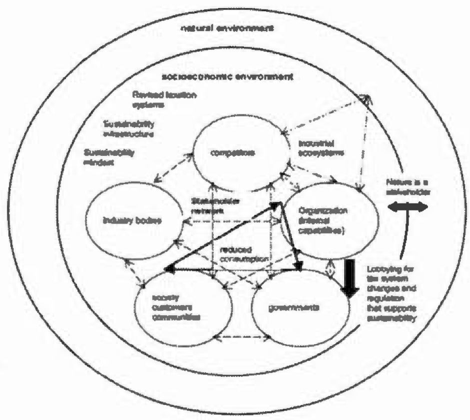
</td><td>D
</td></tr>
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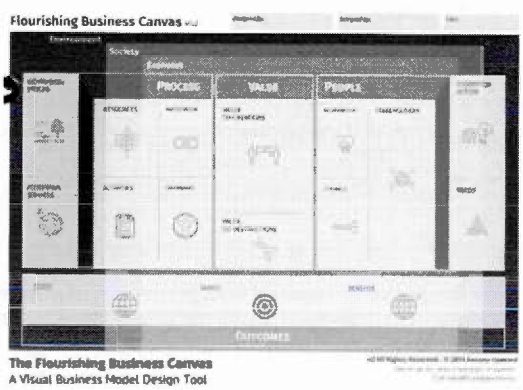</td><td>F
</td></tr>
</table>

Figure 3.8 BMS vs. BMF Designs

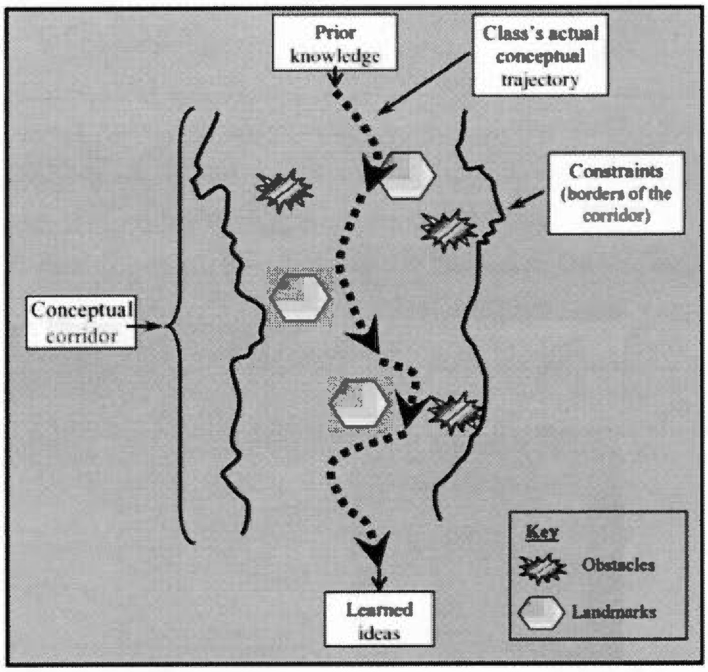

Figure 3.9 BMC, Gamestorming and Learning Corridor

Source: Sawyer (2005: p. 146)

3.8 Conclusion: Designing BM with Strong Sustainability in Mind

As already quoted when defining flourishing approach:

> In this model of economic interactions, business's primary role would be to enable people to flourish—that is, take care of the world around them. Such a world would be very different from what we see today. Eco-efficiency and CSR would still be on the agenda, but the creation of flourishing would come first. It's obvious this would require radical change. (Ehrenfeld, 2004)

Figure 3.12 once again draws parallels between BMSs and BMFs by showing that in the case of BMSs (on the left) BM designers use canvases and existing categories to build BMs and then ask themselves how to transform that BM to a BM for sustainability by using GRI reporting standards or Brundtland's definition of sustainable development. On the right side of the figure, we show another way of proceeding, a way that begins with actors that take care of the world around them. These actors—not all of them business actors—consider problems in the physical environment and how to find solutions using sustainability science. The solutions to be implemented raise awareness about the gap between a healthy planet and un-sustainable situations and practices. They experience personal transformation and with others start to mobilize society toward flourishing conditions. They contribute to producing useful knowledge and creating a next-practice platform.

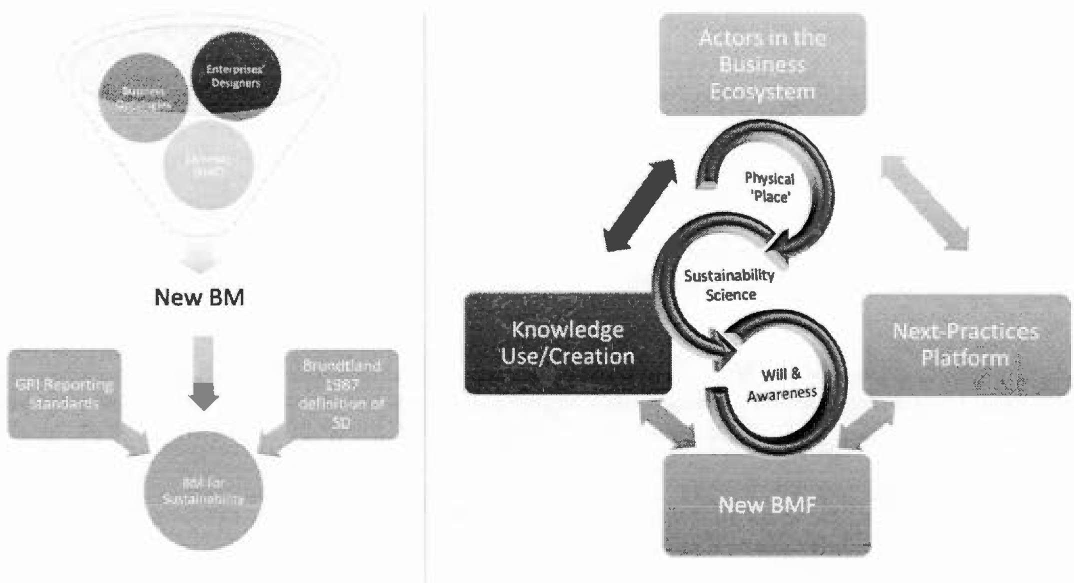

Figure 3.10 Thin BMS Design vs. Thick BMF Design

With BMSs, BM designers—in my classroom experiment – start with categories and are gamestorming until, under supervised learning, an optimal solution is found. A

BMF starts with a vision that requires a radical change. It is a matter of effectuation and backcasting. At the heart of a BMF, there are no predictions and no measures and perhaps too few data to take action. But knowledge use and creation is a huge challenge. While MBA students can produce Figure 2.7. C within 30 minutes, they need weeks and months to produce their own knowledge maps. Another illustration can be the circular economy as described by Jonker (2014).[33] The circular economy is about recycling, parts harvesting, refurbishing and service instead of product. A BM canvas doesn't fit the new capabilities requirements described by circular economists. But those capabilities can be part of a next-practices platform in a BMF design.

[33] Jonker, Jan (2014). Changing the Logic of Value Creation. Exploring organisational ecology as a foundation to create Community based Business Models.

CHAPTER IV

LOGIM@S©: A TABLE GAME TO LET CITY MANAGERS DISCUSS VALUE AND SUSTAINABILITY

4.1 Introduction

Chapter two was dedicated to a reverse classroom experiment where knowledge creation and use (through scenarios) were key to problem solving. In that chapter, it was established that the BMC approach with BMI mapping belongs to thin design practices fitting techno-materiality. Solving complex organizational problems in a world of socio-materiality implies thick design and deep learning through knowledge creation and use.

This chapter, chapter four, delves more deeply into greening issues by introducing physical materiality to our model and defining tutor specifications for our Logim@s© table game experiment. We have already outlined the reasons for thinking about BMF as a regression (from abstract to concrete) from techno- to socio- to physical materiality in chapter one. Physical materiality speaks to 'natural' sciences and knowledge but, at the same time and along with sustainability science, it is dedicated to problem solving more than 'truth' production. Moving from scientific 'truth' to a sustainability solution requires the examination of logical modes as managers develop and implement sustainability actions. Moore (2007) opposes a kind of sustainability that comes both from deduction (Brundtland's 'sustainable development' definition

(1987)) and induction (through GRI reporting practices) to another kind of sustainability generated by abduction. In business literature, abduction is now associated with innovation management (Paavola, 2004) and with problem solving in sustainability and sustainability science; also, referring to Chesbrough (2010), the definition of abduction can be seen as compatible with effectuation. Physical materiality is thus both a matter of science for problem solving—abduction as logical mode—and knowledge use vs. knowledge creation and accumulation.

If the BMC approach does not seem very helpful for BMF design, the proposition needs to be tested. This is the *raison d'être* of chapter four. Inspired by Torres & Macedo (2000) and literature about games and gamestorming (Gray et al., 2010), we invented a table game that combines BMC (thin design and techno-materiality), large cities as social organizations (thick design and socio-materiality) and physical materiality.

Table 4.1 outlines the way physical materiality is paralleled with techno- and socio-materiality. Twelve sentences borrowed from Moore's (2007) field studies illustrate this world of sustainability science, knowledge use and abduction (Table 4.1).

Table 4.1 Moore's (2007) 'Abductive' Sentences Adapted to Krippendorff's (2007) Artificiality Trajectory

Techno-materiality	Organizational Socio-materiality	Physical Materiality (Eco) Management
Products	*Behavior*	*Natural Elements, Cycles, Resources* - (Abduction—Moore) Natural resources have finite limits, but these can be stretched by human mental labour. - (Abduction—Moore) It is not particularly helpful for citizens to be concerned with

		scientific 'truth,' but it is very helpful to figure out what it is that we can do together to solve common problems.
Services	*Structure*	*Eco-Infrastructure Services* - (Abduction—Moore) Conceptual models and lists of best practices are of some heuristic value but tend to divert attention away from local opportunities for action that derive from local storylines already related to sustainable development.
Interfaces	*Interactions*	*Human-Nature Interactions* - (Abduction—Moore) Because humans, nature, and technologies coevolve, changes in one of these variables can never be studied in isolation.
Networks BM as Market Device	*Business Platform*	*Business Platform Model for Flourishing* - (Abduction—Moore) The appearance of new technological codes reflects change social values and stimulate changed social habits - (Abduction—Moore) Be concerned by the consequences of actions more than their qualities—how brave, simple, or generous they are.
Techno-materiality	Organizational Socio-materiality	Physical Materiality (Eco) Management
Projects BM Innovation	*Strategic Capabilities*	*Flourishing Capabilities, Knowledge Use* (Abduction—Moore) Projects are likely to be considered successful by more people when experts depend on citizens to define them. (Abduction—Moore) Efficient design will optimize what is technically possible, but effective design will optimize what is socially desirable. (Abduction—Moore) 'Wicked' problems can be solved by employing experimental design thinking, not by sticking with the same scientific assumptions, traditional values, and social habits that created them. (Abduction—Moore) Methods of

		implementation are theories of conceptualization in disguise
BM as Performative *Discourses*	*Vision*	*Backcasting—Effectuation* - (Abduction—Moore) Although irrational mobs and disciplined clients can both contribute to sustainable conditions in the short run, while rational deliberation among citizens contributes most in the long run. - (Abduction—Moore) Regimes of sustainability tend to show up in culturally diverse spaces where coalitions of environmentalists and social justice advocates redescribe dominant storylines in ways that are attractive to most citizens

Figure 4.1 shows how we connect the three parallel progressions (techno-, socio- and physical). It can be criticized as arbitrary, but we tried to stay coherent with Krippendorff's (2007) category definitions. As a designer, Krippendorff (2007) naturally starts with products as the first concrete category and with discourse as the last and most abstract level. So, physical materiality starts with natural elements, cycles and resources that 'culminate' in backcasting, defined in chapter one as a way to define—not to predict—the future. This chapter presents a table game experiment that occurred in the sustainability division of a large Canadian city: the four players were sustainability directors and professionals. The game is based on Steven Moore's book (2007), which exposes storylines, logical modes and discourses that enable three very different cities (Curitiba, Austin and Frankfurt) to deploy sustainability leadership. A thick design challenge lies at the heart of the experiment: how can a player connect the BMC approach with each city's contradictory discourses and 'abductive' sentences on the physical materiality axis? Are the players in inductive/deductive logical mode, or will they move on to abductive mode?

The goal of this chapter is both to experiment more with a BMC gamestorming approach, rather than with a gamification approach (Deterding *et al.*, 2011), that integrates sustainability ('sustainable development,' as defined in Brundtland, 1987) into an innovative BM design (Baden-Fuller & Morgan, 2010; Zott & Amit, 2010). This will allow us to develop ideas for a tutor dedicated to this integration. The fecundity of intersecting gamestorming (Gray et al., 2010) with BMI has made BM mapping a success (Osterwalder & Pigneur, 2010).

4.2 Logim@s©: A Table Game Architecture

The objective for the players is to make propositions to introduce better sustainability measures that mitigate the significant effects of a highway interchange implementation project. Each player must present his or her propositions using a BMC in the given context of the city to which each player has been randomly assigned. The ability or capacity to make valued proposals will determine the best sustainable business model. So, the main steps of the experimental research design are the following. We designed a table game from scratch that would match the characteristics of sustainability managers in a big city. Applying Moore (2007), conceptually we based the game on research about sustainability introduction in the policies of big cities: Curitiba (Brazil), Austin (United States), and Frankfurt (Germany). Practical speaking, Logim@s© consists of 52 playing cards with printed material specific to four cities (we added a Canadian city) separated into three categories (Figure 4.1):

- Cards with city discourse excerpts: For each city, Moore (2007) documented a storyline, together with political, environmental and technological dominant and alternative discourses.
- Cards about GRI and SD (sustainable development 1987 definition): These cards illustrate mainstream inductive and deductive approaches to sustainability.

• Cards with abductive sentences from Moore (2007): After having presented the cities' storylines and sustainability approaches, Moore proposes 12 guiding sentences to cope with contradictory discourses around sustainability.

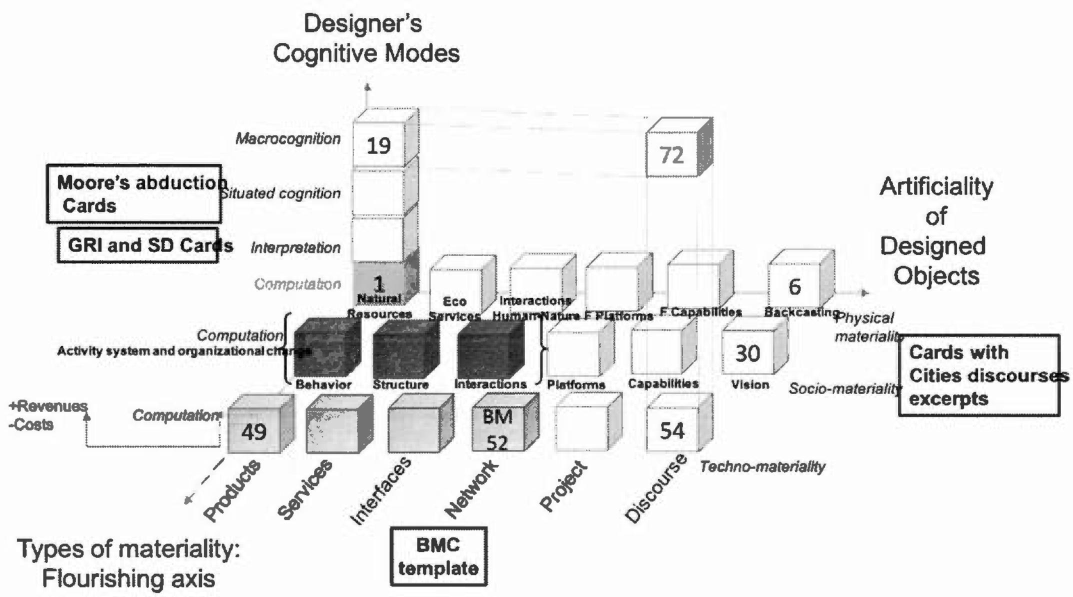

Figure 4.1 Logim@s©: A Table Game Architecture

We chose the sustainability unit of a large Canadian city where four managers and professionals agreed to play the game. The game was followed by a debriefing period wherein the participants drew their own conceptions for a highway interchange 'greening' project on pre-print BMC posters.

- The game period was approximately one hour and audio and video recordings were made.
- The transcript was software coded (NVivo 10) to answer research questions.
- Six months later, control interviews were conducted individually with each manager to identify key issues and challenges in the construction of a new

> business model. Our main concern was to understand how managers acquainted with sustainability theories, tools and techniques, considered using BMC to brainstorm or 'gamestorm' (Gray et al., 2010) around the large infrastructure project defined in the game.

The guiding idea is that we can find such managers and professionals in the 'sustainability unit' of a large city. Large cities have to manage time/space constraints (Bansal & Knox-Hayes, 2013) and the materiality of a specific ecological infrastructure. Unlike multinational companies, large cities—like New Orleans—are directly and physically threatened by environmental change. Their managers are used to coping with natural threats and catastrophes (for example, hurricanes Sandy and Katrina), and are thus ahead of their time in terms of their capacity to implement sustainability in the city policies and design specifications of their projects (Marcotu & Solecki, 2013). To capture the attention and mobilize the ideas and competencies of these professionals and managers, a table game can simulate the implementation of a major highway interchange project within the cities of Curitiba, Austin, Frankfurt and a Canadian city (Figure 4.2). By designing a table game that brings the players to a debriefing period supported by a BMC, this chapter examines the interplay between BMC gamestorming and physical materiality.

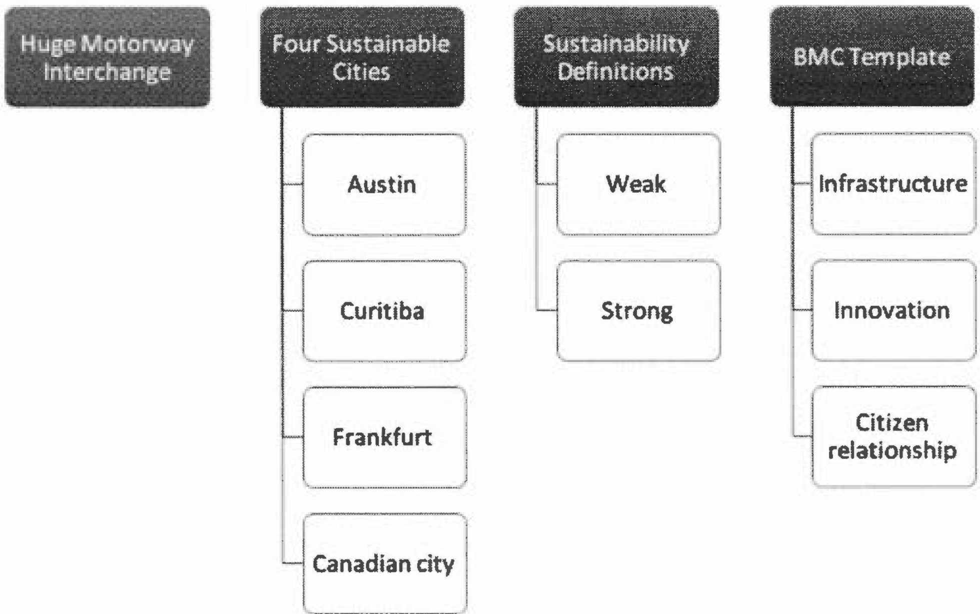

Figure 4.2 Four Key Explicit Dimensions in the Logim@s© Game

4.2.1 One BMC Template

The BMC template (Figure 4.3) is adapted from Osterwalder & Pigneur (2002). In fact, only one category label is renamed: on the left side 'Customer Relationships' becomes 'Citizen Relationships.' All other labels remain the same as in the original version.

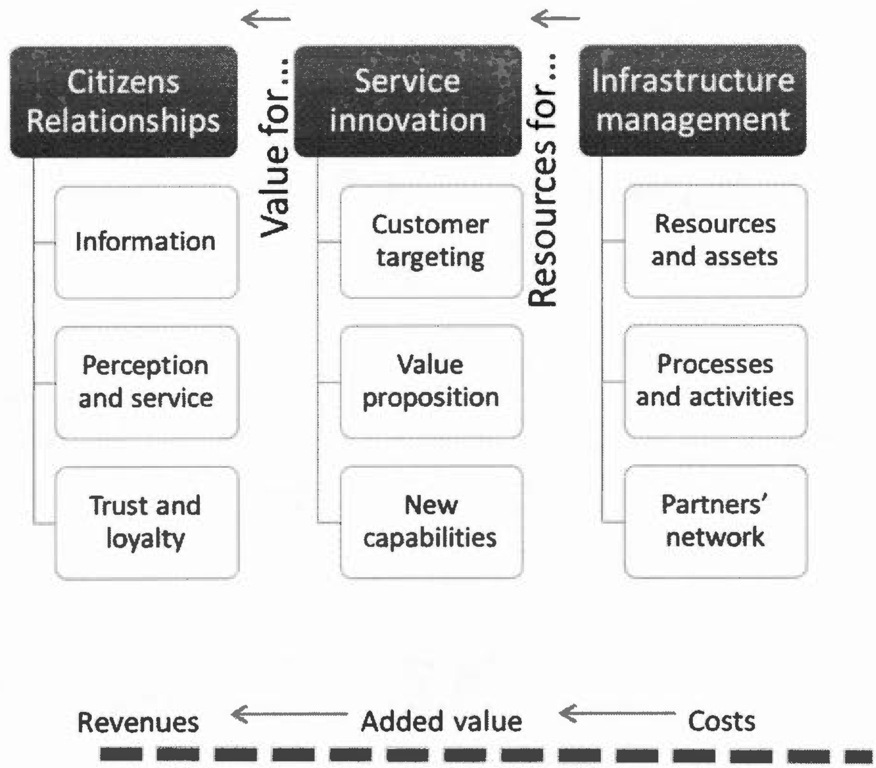

Figure 4.3 BMC Template to Illustrate How Sustainability Should Take Place in a Highway Interchange Project

Source: Osterwalder & Pigneur (2002)

4.2.2 Three Kinds of Cards: City Discourses, SD-GRI and Other Cards (Abduction)

Table 4.2 Card Description for Logim@s© Game

City	Curitiba	Austin	Frankfurt	Canadian city
C A R D S	♥	♦	♠	♣
Dominant discourses				
Ace	Political			
King	Environmental			
Queen	Technological			
Alternatives discourses				
Jack	Political			
10	Environmental			
9	Technological			
Support cards				
8	SD 3 pillars	GRI logo	Other card 1	Other card 7
7	SD semantics	GRI standards	Other card 2	Other card 8
6	SD hierarchy	GRI transport 1	Other card 3	Other card 9

5	SD transport 1	GRI transport 2	Other card 4	Other card 10
4	SD transport 2	GRI transport 3	Other card 5	Other card 11
3	SD transport 3	Relevant data	Other card 6	Other card 12
2	A toggle card to shift between weak and strong sustainability			

Verbal exchanges between 'cities' are encouraged provided that they are conducted with reciprocal knowledge of contexts (e.g. do we have the same values in relation to the environment, technology?). The SD, GRI and OTHER cards are exchangeable between two cities as long as the two cities remain faithful to their own context; at this time, it is permitted to display cards on the table to better understand each other. A 'two' card (cards with the value 2) requires the neighbour to the left to implement strong sustainability. It is written in the game rules that economics (Nielsen *et al.*, 2010) and strategic management (Hart, 1995) literature both distinguish weak sustainability (the control of toxic emissions for various industrial processes or 'end-of-pipe control') from strong sustainability (the leaders' commitment to sustainability).

- Weak sustainability is associated with compensation calculation for environmental damages (e.g. the carbon market) and supports the principle of substitution between economic and ecological resources. This is what forms the strategy of followers (MIT, 2011).
- Strong sustainability means that business leaders have a vision of sustainable development in the context of trade relations between north and south (Hart, 1995). It is no longer a matter of compensatory calculation but a redefinition of the mission of the company and its transformation around this notion of sustainability. This is the 'Embracers' innovative strategy (MIT, 2011).

4.2.3 A Game Between Work and Theories of Work

Our goal is to design a game space in accordance with the definition of Gray et al. (2010): "To enter into a game is to enter another kind of space where the rules of ordinary life are temporarily suspended and replaced by the rules of the game." Around the table, a player can spontaneously assume a new role induced by the game or stay bound to a professional role in city administration and experiment with cognitive inertia.

We assume that the players entering the space of the game are ready to adapt to an unknown situation and take some risks when their beliefs are threatened. But creating this new space implies an appreciation of the distance between that space and the everyday workspace. At the end of the game, during the debriefing period, a mapping effort is required from the players who received an BMC template to expose their vision of how to introduce sustainability to the interchange project.

The transcript reveals a balance between items of "anchoring up" (Engeström, 2004) (toward concepts, models and history) and items or vignettes of "anchoring down" into the world (toward cases, experiences and ethnography).

An example of anchoring up, verbatim, is:

> So, we must immediately begin to incorporate into our planning the facts that cheap oil will be less and less available, it will be increasingly hot and the population will be increasingly aging. So, there are major issues that will hit us anyway: how do we think about managing our infrastructure based on these major issues?

And an example of anchoring down: "Well, it seems to me that it must be an unmanageable situation in Austin. In my management values, the conflict exists only because of the uncertainty and inflexibility of experts."

4.3 Hypothesis on Cognition Axis

Along the cognition axis we see a progression from computation to macrocognition and its preconditions as defined in chapter one. 1. Computation is what a computer can do. 2. Induction and deduction are (abstract) logical reasoning modes described by Moore (2007) in connection with the usual notion of sustainability. 3. Symbol-grounding and situated cognition set the table for interpretation; sustainability is not an abstract problem but a place-based problem that can modify human sensorimotor states (and that of all living beings). 4. Interpretation is about how meaning is created around information in a social context. 5. Abduction is a logical mode associated with discovery and innovation. 6. Finally, macrocognition is group cognition where required conditions around legitimacy and the absence of hierarchy are respected.

4.3.1 Computation

The computational approach to sustainability can be equated with an approach that is defined by the use of the digital computer. But even the organizational sustainability computationalists must work on an interpretation of the concept of sustainability, and they will quickly reframe it in a dynamic systems approach. For example, GRI reporting modules are implemented in integrated enterprise resources planning (ERP).

4.3.2 Induction—Deduction

Here is a summary of Moore's critique of the model (deduction) and the list (induction)[34] as logical modes to implementing sustainability in a large city (Figure 4.4): "1. They are idealized, pre-political, 'thin', or abstract; 2. they are static ; 3. the Brundtland model reflects only one kind of democracy—liberal capitalism; and 4. it is solipsistic.[35]"

Here is Moore's critique of inductive lists:

> "1. [P]athways [to sustainability] do not exist as ideal types but are contested in particular urban contexts, as competing social actors grapple with the concept [or discourse] of sustainable development" (Guy 2000). 2. [I]nductive logic requires a move from the particular to the general based upon the laws of probability (James 1897). 3. [W]hen local conditions are measured against universal best practices they are experienced as obstacles to be overcome rather than opportunities for action." (Source: "Sustainable Cities, Storylines and post-Katrina New Orleans," communication made to the Society for the Advancement of American Philosophy, in San Antonio, Texas, March 10, 2006).

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[34] Moore's definition doesn't fit Fodor's view of abduction. The debate is not easy to follow: "Fodor concludes that abduction may well be a Chomskian mystery on par with the 'hard problem' of consciousness (2001, p. 99). But this mystery mongering may be premature. In what follows, I hope to show that a hybrid computational-associative theory of mind is able to solve Fodor's riddle. The upshot will be that Fodor is right to think that CTM cannot account for abductive reasoning, but wrong to think that abduction cannot be accounted for. If we merely add a soupçon of empiricism to his rationalistic psychology, we may be able to transform the mystery of abduction into a mere problem. But that comes later. Only after a patient review of the details will we be in a position to solve the riddle." (Rellihan, 2009)

[35] "The theory of solipsism also merits close examination because it relates to three widely held philosophical presuppositions, each itself fundamental and wide-ranging in importance: My most certain knowledge is the content of my own mind—*my* thoughts, experiences, affects, etc. There is no conceptual or logically necessary link between mental and physical—between, say, the occurrence of certain conscious experience or mental states and the 'possession' and behavioral dispositions of a 'body' of a particular kind (see the brain in a vat). The experience of a given person is *necessarily* private to that person." (EN_Wikipedia, January 2015)

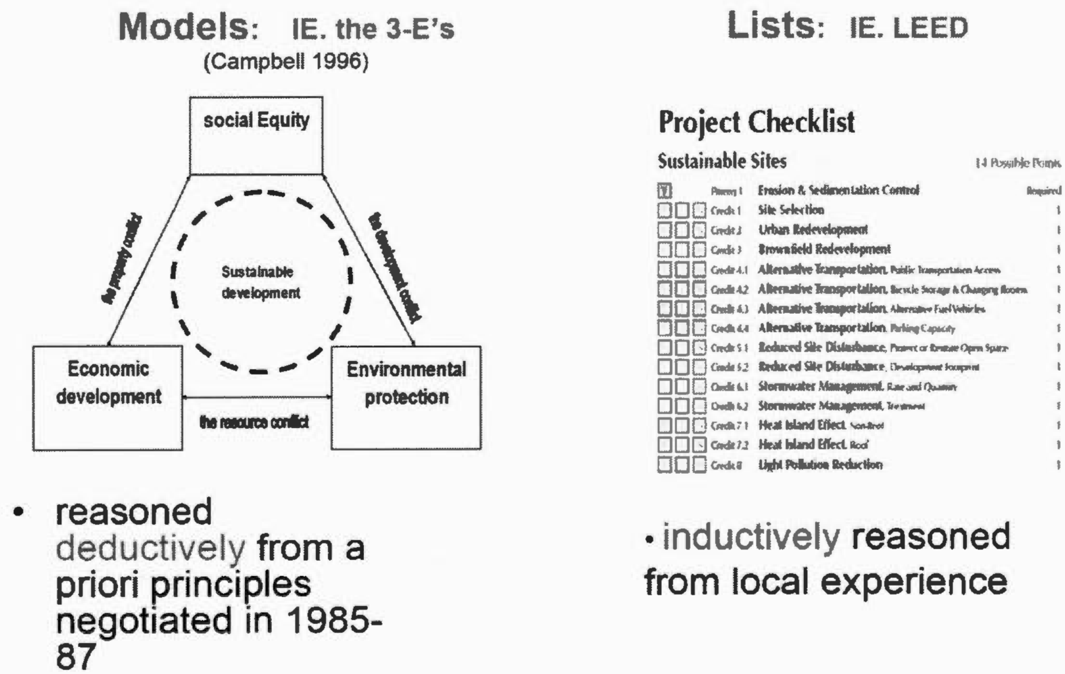


Figure 4.4 Deduction and Induction as Logical Modes in Sustainability Domain

4.3.3 Symbol-grounding, Situated Cognition and Interpretation

What this thesis' author experimented on was a gamestorming tutor that players use to run their own 'real' referents inside a game space. Long ago, Newell noted that, in a given virtual problem space, people behaved as if they were obliged to comply with real physical rules. While working on different projects, managers and professionals have developed a way of thinking about sustainability. During the game, Brundtland's definition (deductive modeling approach following Moore (2007)) was shared naturally. Even if one player had to implement strong sustainability, he didn't change his usual vision and said: "I'll start with my referents and my experience here in this Canadian City." Perhaps the situated cognition approach can help to understand how and why what is situated inside game space is in fact situated outside game boundaries, meaning that our referents cannot be 'played'!

To develop a situated cognition angle, we start with a chapter from the book edited by Robbins & Aydede (2009) entitled *Situated Cognition*. In the chapter in question, the authors present "a bird's-eye view on the conceptual landscape of situated cognition as seen from each of the three angles noted previously: embodiment, embedding, and extension" (p. 3). Following Robbins and Aydede (2009), interest in the embodiment has several sources which point to a concern about the basis of mental representation, particularly the "symbol-grounding problem."

> "Without the cooperation of the body, there can be no sensory inputs from the environment and no motor outputs from the agent—hence, no sensing or acting" (p. 4). Robbins and Aydede (2009) make the distinction between online sensorimotor processing and off-line processing. Online processing occurs "when we actively engage with current task environment, taking in sensory input and producing motor output" (p. 4). This can be observed during the game when players are actively trying to understand another player's strategy in order to prepare card trading. Eye movement and gestures are associated with card trading practice (Figure 4.7). "Off-line processing occurs when we disengage from the environment to plan, reminisce, speculate, daydream, or otherwise think beyond the confines of the here and now" (p. 4).

Off-line processing can be associated with an Austin city player who remained still during the gamestorming; he didn't exchange cards with other players or fill out the BMC template. During the control interview (months later), he mentioned that he had no concrete data to work with and that, logically, the Austin discourses were so incompatible that he was cognitively stuck in a gridlock. He was in off-line processing mode, disconnected from inputs, and using his working brain only: "Off-line embodiment refers to the dependence of cognitive function on sensorimotor areas of the brain even in the absence of sensory input and motor output" (p. 4-5). In contrast, players VV and TT had continuous exchanges about their choices and the cards they wished to trade:

- TT: Well, that's good! I will stick with this card. And what will you give me in exchange for this card?
- VV: I have two things.
- TT: Alright, you're giving me a choice.
- VV: This one may be interesting, in a sense, for someone who wants to integrate the research component more: study, science, and knowledge acquisition.

4.3.3.1 Situated Cognition

In this case, online processing is at work: "online embodiment refers to the dependence of cognition—that is, not just perceiving and acting but also thinking—on dynamic interactions between the sensorimotor brain and relevant parts of the body: sense organs, limbs, sensory and motor nerves, and the like" (p. 4). Socially active players involved in online processing are developing what Sperber and Mercier (forthcoming) call "reasoning as a social competence." Following these authors:

> Reasoning, we have argued, is a specialized metarepresentational competence with a primarily social cognitive function. It is both structurally and functionally quite different from intuitive inferential mechanisms that have primarily individual cognitive function. (p. 22)

After the individual debriefing period, all the players went outside game boundaries and started to reason about the sustainability evaluation process.

In the gamestorming approach and particularly with Logim@s©, the closing period is a debriefing period. During this period, every player justifies their choices, but quickly their arguments are mapped onto the issues at hand and onto everyday work. By the end of the game, players are reasoning about their common projects at a higher level of abstraction… whose benefits are social benefits:

> Reasoning is quite generally viewed as an ability aimed at serving the reasoner's own cognitive goals. If so, the contribution of reasoning to 'collective wisdom' (…) We want to argue, on the contrary, that the function of reasoning is primarily social and that it is the individual benefits that are side-effects. (Sperber & Mercier, 2010: p. 1)

> When argumentation and hence reasoning are at work, they shape the outcomes of group processes. In many cases, this is for the best—more information is shared, superior arguments are granted more weight. Sometimes, however, reasoning creates a *polarization* of the group. (Sunstein, 2002) (Sperber & Mercier, 2010: p. 23)

And

> …we need to consider also the complex transactions between embodied minds and the embedding world. One type of such a transaction is the use of strategies for off-loading cognitive work onto the environment, a useful way to boost efficiency and extend one's epistemic reach. (Sperber & Mercier, 2010: p. 6)

Gamestorming artefacts are means to off-load cognitive work. Arranging the cards by city, by discourse, by SD, by GRI or other cards, as with checking the BM template and printed rules, is a means by which to off-load cognitive work. But the human tutor seems to be the preferred link between embodied minds and embedded world. He is involved, with 50% of his input being verbatim. Except for the closing period with individual debriefings, he is continuously solicited to validate the rules, the discourses and the meaning of the cards and of some definitions like strong sustainability and, outside the game's boundaries, to validate information about the simulated cities, Curitiba, Austin and Frankfurt.

4.3.3.2 Interpretation

Even if political and economic forces are very antagonist and seemingly irreconcilable, big cities that moved toward sustainability succeeded in building a common storyline to avoid ecological collapse with opposing environmental, political and technological discourses (Moore, 2007).

Consequently, Moore goes further by saying:

- Models and lists of SD can be helpful as heuristic and analytic tools.
- However, they tend to suppress the local "public talk" required to motivate action in a particular place.
- The recognition of un-sustainable conditions in any particular place implies a storyline with 3 possible responses: 1. denial 2. Malthusian "over-shoot" and collapse 3. sustainable development—a storyline that avoids ecological collapse.
- A storyline is a shared way of making sense of the past and speculating about what might become true in the future (Dryzek 1997).

(Source: "Sustainable Cities, Storylines and post-Katrina New Orleans," communication made to the Society for the Advancement of American Philosophy, in San Antonio, Texas, March 10, 2006).

4.3.4 Abduction

Moore (2007) makes the distinction between deductive, inductive, and abductive logical modes in use during the journey. If experimentation with a BMF implies starting with deductive logic, it flows—following Moore (2007)—from the definition of sustainability itself (Brundtland et al., 1987). If city managers start with inductive logic, it is from a reporting template such as that proposed by the GRI[36], or 'homemade' by any organization. If city leaders and managers are taking action without all the necessary information once they recognize a pattern, they are using abductive logic. Having written down the cases for the three cities, Moore concludes

[36] GRI (Global Reporting Initiative), a non-profit organization based in Amsterdam since 1997 and created by CERES, Coalition for Environmentally Responsible Economies, is an NGO based in Boston and a central actor in the integration of environmental issues into business activities. The GRI developed guidelines for sustainability reporting that have become over the years a standard for triple reporting: financial, environmental and social.

by summarizing twelve lessons than can help local initiatives conceived in an abductive logical mode:

1. Regimes of sustainability will tend to show up in culturally diverse spaces where coalitions of environmentalists and social justice advocates redescribe dominant story lines in ways that are attractive to most citizens.
2. Projects are likely to be considered successful by more people when experts depend on citizens to define them.
3. Efficient design will optimize what is technically possible, but effective design will optimize what is socially desirable.
4. Natural resources do have finite limits, but these can be stretched by human mental labor.
5. Because humans, nature, and technologies coevolve, changes in one of these variables can never be studied in isolation.
6. The appearance of new technological codes reflects change social values and stimulate changed social habits.
7. 'Wicked' problems can be solved by employing experimental design thinking, not by sticking with the same scientific assumptions, traditional values, and social habits that created them.
8. Be concerned by the consequences of actions more than their qualities-how brave, simple, or generous they are.
9. It is not particularly helpful for citizens to be concerned with scientific 'Truth,' but it is very helpful to figure out what it is that we can do together to solve common problems.
10. Conceptual models and lists of best practices are of some heuristic value but tend to divert attention away from local opportunities for action that derive from local story lines already related to sustainable development.
11. Although irrational mobs and disciplined clients can both contribute to sustainable conditions in the short run, rational deliberation among citizens contributes most to the long run.
12. Methods of implementation are theories of conceptualization in disguise.

Each of the above statements is printed on OTHER cards, support cards that are distinct from sustainable development (SD) cards and GRI cards, respectively 'MODEL' cards and 'LISTS' cards in Figure 4.1.

Sperber and Mercier (forthcoming) define reasoning as follows:

> We have suggested a more explicit and principled distinction between 'intuitive' and 'reflective' inferences (Mercier & Sperber, 2009) that can be seen as a particular version of dual systems theories provided they are broadly

> characterized, or else as an alternative to these theories, drawing on much of the same evidence and sharing several fundamental hunches. We argue that 'system 1' or intuitive inferences are carried out by a variety of domain-specific mechanisms. Reflective inference, which corresponds to reasoning in the ordinary sense of the term, is, we claim, the indirect output of a single module. A distinctive feature of our approach, relevant to the discussion of 'collective wisdom,' is the claim that the main function of reflective inference is to produce and evaluate arguments occurring in interpersonal communication (rather than to help individual ratiocination). (p. 6)

In one of his abductive sentences, Moore (2007) writes: "Although irrational mobs and disciplined clients can both contribute to sustainable conditions in the short run, rational deliberation among citizens contributes most to the long run." This rational deliberation among citizens is compatible with Sperber and Mercier's definition of 'collective wisdom.'

4.3.5 Macrocognition Conditions

According to Huebner (2013), as quoted in chapter one, macrocognition[37] or 'group cognition' implies three preconditions in order to be a living phenomenon.

Moore (2007) would agree with Huebner when he states that:

- rational deliberation among citizens contributes most to the long run,
- local opportunities for action that derive from local story lines,
- we can do together to solve common problems and

[37] "That is, if the intentional stance produces useful explanations and prediction of group behavior, it is because there is a certain cognitive structure in place, and we need a story about that structure in order to move from the explanatory practice described in intentional stance theory to a cognitive science of group minds. To address this need, Huebner couples the intentional stance with a theory of cognitive architecture. In so doing he provides not only a compelling account of macrocognition (group cognition), but also a compelling picture of how intentional systems theory can be wedded to a cognitive science of the mind." (Website http://ndpr.nd.edu/news/47449-macrocognition-a-theory-of-distributed-minds-and-collective-intentionality/, visited on December 2, 2014)

- projects are likely to be considered successful by more people when experts depend on citizens to define them" complies to Huebner's Principle 1: Do not posit collective mentality where collective behavior results from an organizational structure set up to achieve the goals or realize the intentions of a few powerful and/or intelligent people. (p. 21)

4.4 Observing Game Progression

Timing. 11:00 a.m.: Set-up and indications for the game. 11:10: Game begins. 11:25: Drawing BMC template for the mega motorway interchange. 11:35: Debriefing. 12:10: Game ends.

The three periods in this gamestorming exercise (Figure 4.5) were easily observable. In the opening, the players were shy, but became more comfortable during the exploring phase when they were able to express their strategy and ask their partners to exchange support cards. And, finally, after having mapped out their ideas on the proposed BMC template, they started to apply and share by analogy what they found to be similar in the highway exchange and in a related waste-recycling project they worked on.

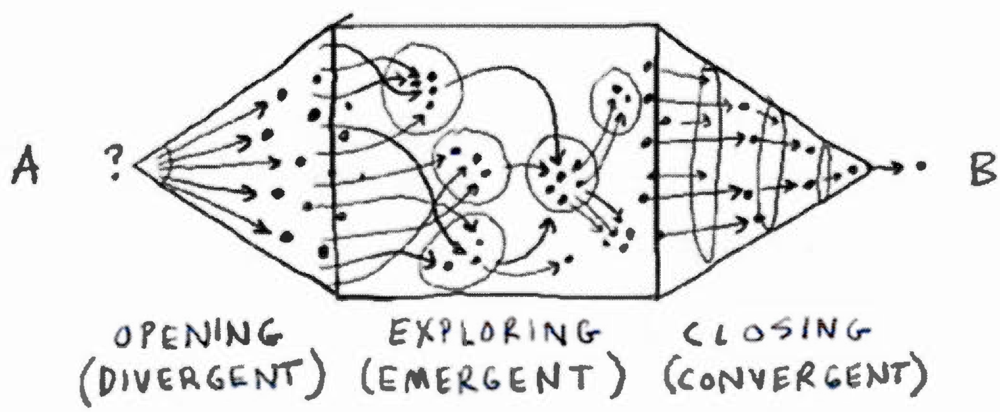
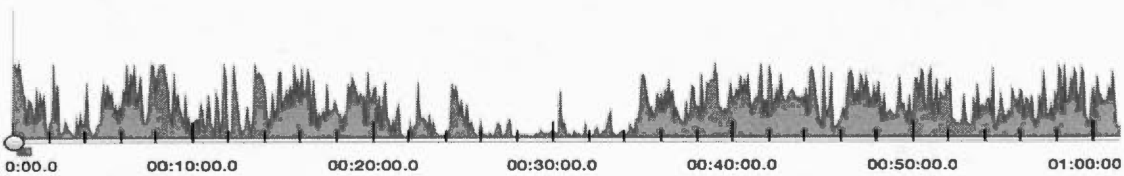


Figure 4.5 Three Periods in Gamestorming

Figure 4.6. illustrates the three periods from the game soundtrack. After five minutes, players had in hand all the artefacts that they would use during the game. Some read the three pages of game instructions; others examined their cards while BMC templates were visible on the table. As shown in the soundtrack profile, the opening of the game contained short periods of silence interspersed by questions for the tutor and first attempts at exchanging cards. Due to time constraints, after play had taken place for 25 minutes, the tutor asked the participants to complete the BMC templates, and for more than 12 minutes no words were exchanged, as each player was busy completing their model alone. This period was followed by debriefing periods and then a final group conversation. During the closing period, the soundtrack reveals intense and continuous verbal exchanges.



Opening Exploring Closing—Individual debriefing Closing—Group debriefing

Figure 4.6 The Game's Soundtrack

From a cognitive point of view, the workload was heavy for one hour of gamestorming. Each player had to read the three pages of rules, remember what the highway interchange was all about in the context of the chosen Canadian city, transfer this project to another city's context, learn the context through statements written on cards, try to build a persuasive case where sustainability is part of the business model by assembling cards (Table 4.1), transpose their thoughts onto a (unknown) business model canvas template (Figure 4.7) and set aside some time for the debriefing period where they would need to demonstrate some mastery.

The game associated a project to the cities: a huge, multibillion-dollar highway interchange with profound impact on residents' quality of life, transport efficiency, balance between public and private transportation means, pollution, CO_2 emissions etc. This kind of project was a major political and sustainability issue in the Canadian city chosen for the experiment:

> Projects are primarily social artefacts. They involve people as stakeholders who cooperate in bringing something of joint interest to fruition. To the extent that projects are self-organizing, they are not entirely controllable from their outside. Designers may influence a project by participation. They may enroll stakeholders in their vision. But they may not be able to control how projects proceed and determine their outcome (Krippendorff, 2007:19).

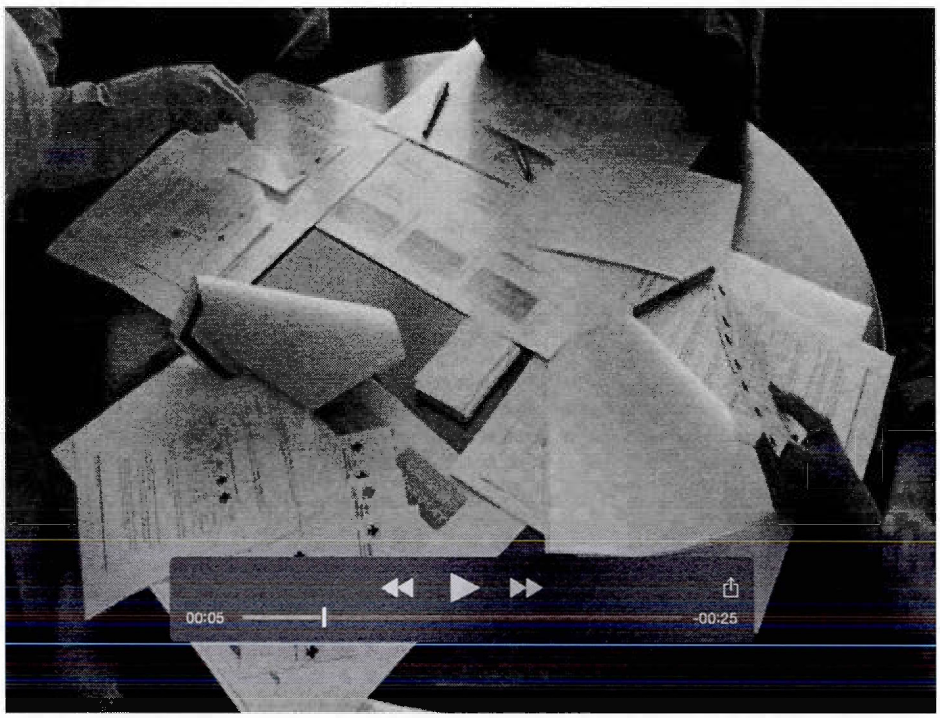


Figure 4.7 Players During Opening Period

Moore's book is about logical modes, storylines and discourses. He analysed political, environmental and technological discourses in the three cities both from the politically dominant view and environmentalists views. The discourse is the most abstract level for any artefact:

> Naturally, the final kind of artefact in the trajectory is discourse, an institutionalized communication and a constrained way of languaging. In discourse, particular ways of languaging dominate reality constructions and direct the practices of the members of a discourse community (Krippendorff, 2007:19).

But the more concrete levels of sustainability were also taken into account during the game. Once the players understood the storyline and were able to tie apparently irreconcilable discourses together, they benefited from the support cards derived from Moore's three logical modes to grasp sustainability issues inside a large city: applying a deductive logical mode from sustainability and sustainable development definitions, applying an inductive logical mode from GRI definitions or practicing abduction and acting locally with available resources.

4.4.1 Gamestorming Components Acted Upon by Players

Figure 4.8. shows that the human tutor (TUTOR) is the most frequently implicated in verbal exchanges about: 1. Rules for interaction and 2. Artefacts (cards and BMC template). Other elements like goals or game space are less frequent.

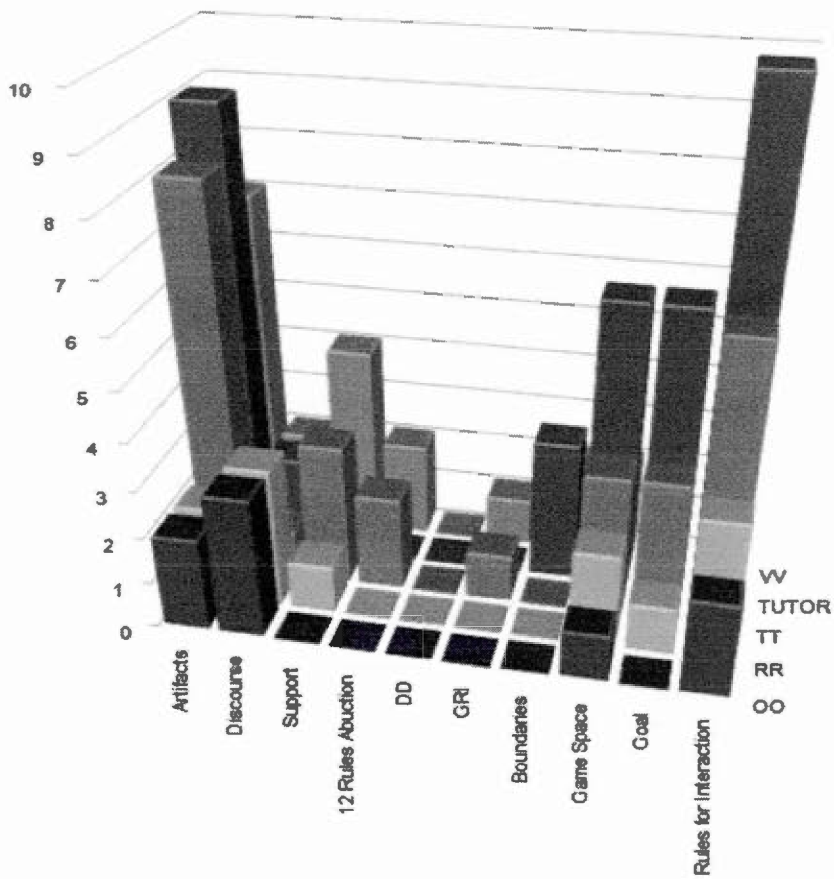


Figure 4.8 Gamestorming Elements Acted Upon by Players

4.4.1.1 Game Space

One player refused to enter the game space because he felt that he wasn't prepared enough and did not have sufficient information. He said: "I do not feel myself to be a good enough lab rat! And, later, 'I'm not sure I understand what I need to do." During the debriefing interview, a few months after the game, he underlined lack of quantitative data as the reason why he did not enter the game space.

4.4.1.2 Rules for Interaction

The following exchanges show how tutor-assisted players entered the game space and followed the rule of interaction.

- OO: I'll trade a card with you. I'll get rid of the GRI. RR might be interested in it.
- VV: Okay. So, I must have a strong sustainability strategy.
- TUTOR: Yes, ok. And to do that, you will always keep your six city cards and six support cards (...)
- VV: OK.
- TUTOR: And at some point, you will want to trade on your support cards in order to support your strong strategy.
- VV: OK. Let's say I want to try to cover the social dimension… the social dimension card and then the economic dimension card?
- TUTOR: Yes, this can be a valid option.
- VV: Then, I can make a trade here, right?
- TUTOR: Yes, with someone who is willing to trade with you.
- VV: Can I offer you a cards' exchange here as well?
- TUTOR: Here, if we respect the turn of the cards, it would be OO's, then TT's, turn to offer a trade.
- VV: OK.

Another dialogue about the cards' illustrations (the game took place the week after the April 22, 2012, Earth Day demonstration and 'abductive' cards were illustrated with pictures of the demonstration):

- TT: Ah! It's like it's a brand-new card game. (laughs)
- TT: I even see the tree or the hand, the human hand at the end of last weekend. It's a beautiful hand; it's great!
- TUTOR: Yes, yes, it is a nice idea. Luckily, there was a little light. It did not rain!

About GRI:

- TUTOR: You could choose a GRI series.

- TT: OK. Send me a GRI; I like GRI 5 better than GRI 4; what is written in economic dimension is what I like least.

About 'OTHER' ('abductive') cards:

- TUTOR: Whose turn is it here? Is it OO's?
- TUTOR: Maybe OO could leave her game open (...) as this is her strategy. It is a strategy without DD and without GRI.
- OO: I have no DD or GRI.
- TUTOR: That's an 'OTHER' card.
- OO: OTHER?
- TUTOR: The cards with the image of a hand are 'OTHER' cards.
- OO: And?
- TUTOR: Here, you can have multiple strategies...or you combine these cards. Alternatively, you could try a DD series or series GRI.
- OO: By trading?
- TUTOR: By trading.

4.4.1.3 Artefacts

The human tutor had to explain the purpose of artefacts:

- RR: Ah, but the cards are in opposition!
- TUTOR: Yes, that's right. There is a logic of opposition between the two discourses, dominant and alternative discourses, whether technological, environmental or political. This comes from a study done in the field in the three cities of Curitiba, Austin and Frankfurt.
- RR: (…) Are these true discourses for Austin?
- TUTOR: Yes, these are real.
- (…)
- VV: I'm missing the environmental aspect! The SD (Sustainable Development) environment card. Is there one? It is with you somewhere?
- TT: SD environment? It should be (...) It should be...
- VV: Does she have an SD environment card?
- TT: Yes, I have something interesting for you… cnvironment.
- VV: SD
- TT: No, no (...) it isn't, it isn't an SD! It's here, it's here... Ah, there it is. There it is. It's the DD5.
- VV: I love it. I love it here.

4.4.2 Closing: Individual Debriefing

The game ended with a debriefing period for each player who laid out how they would introduce schemas supporting the sustainability of a mega highway interchange project in the city they were representing. The four people around the table knew each other very well; they worked in the same sustainability direction. They hold graduate studies degrees (three at the master's level and one at the PhD level) in disciplines such as architecture, landscape architecture, environmental sciences or engineering. The participants ranged in age between 35 and 55 years.

Twenty-five minutes before the end of the scheduled game time, players presented their solution and engaged in discussion to designate a winner: which city had the best sustainable business model for the installation of a mega motorway interchange on its territory? The players were stimulated by and concentrated on the proposed mapping challenge based on the Osterwalder & Pigneur (2002) canvas. They produced three different maps. The interpretation of these maps required further control interviews with the players. However, an idea shared by all the players was that they tried—when possible—to work the proposed canvas the other way, from citizen relationship to infrastructure definition.

A debriefing time was dedicated to *mapping*: For 12 minutes, perfect silence reigned over the group of players who individually completed their canvas with no interaction, even though no instruction was given. Two players in particular took their role in the game very seriously as planning leaders in Curitiba and Frankfurt, examining the text printed on the 'city' cards in depth and trying to get appropriate support cards: "So, we put ourselves in the shoes of a manager of the city of Curitiba."

4.4.2.1 OO—Playing Frankfurt

The OO player was very sensitive to the meaning of Frankfurt's discourse cards. Her strategy was to trade 'OTHER' cards only to show that—in her mind—the interchange project would never be supported and approved by the city. Based on 'abductive' cards, her reasoning and interpretation was tainted with abduction because she committed herself to a vision of the future in absence of data; only discourses were analyzed to reach this position (Figure 4.10). The clarity in the analysis of discourses was hard to report on the BMC framework (Figure 4.9).

> Yes, the dominant political discourse is about tolerance and skepticism while continuing optimization—freedom to pursue research of individual happiness—so individual happiness is also important. The active conceptualization of space and movement naturally creates conflict, so I read it as something where the policy will be ready to open the debate. OK. Then the wicked problems can be resolved not through scientific assumptions but with an emerging thought of an experimental design. An experimental design that is both experimental design and physical infrastructure and process. /.../ So, at that time, we built a political discourse that could lead in some sense to a challenge to the ontology of the interchange project itself with the tolerance and scepticism.

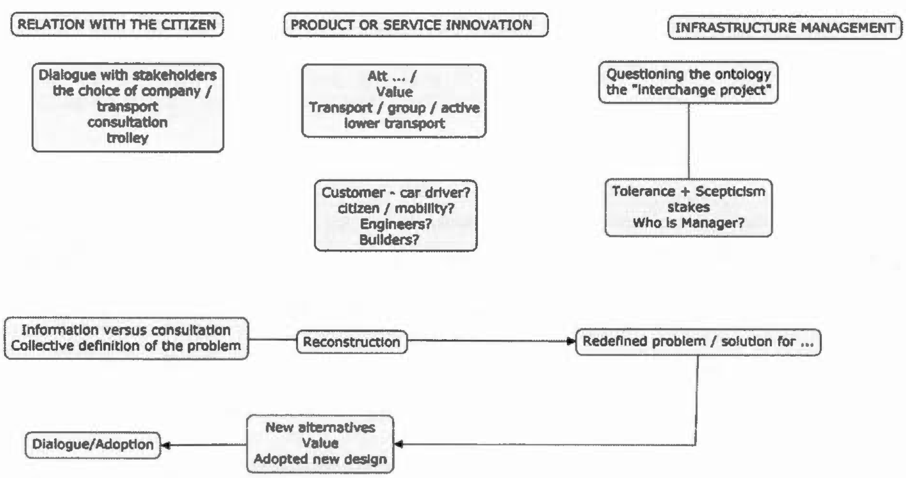


Figure 4.9 Transferring OO's Analysis onto the BMC Template

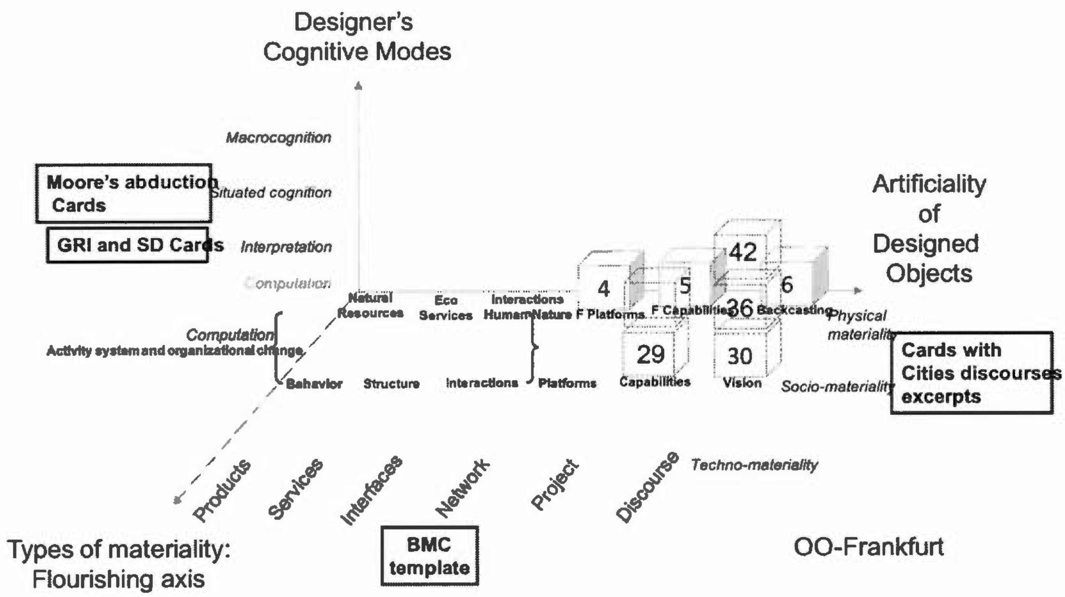


Figure 4.10 OO Player's Full Profile on Three Axes Model

4.4.2.2 RR—Playing Austin

The RR player was upset with incompatible discourses. Reasoning strictly, he could not come up with a satisfying interpretation of what was happening in Austin in terms of sustainability and didn't see how Austin could be a leader in sustainability. Nothing was noted on his BMC template.

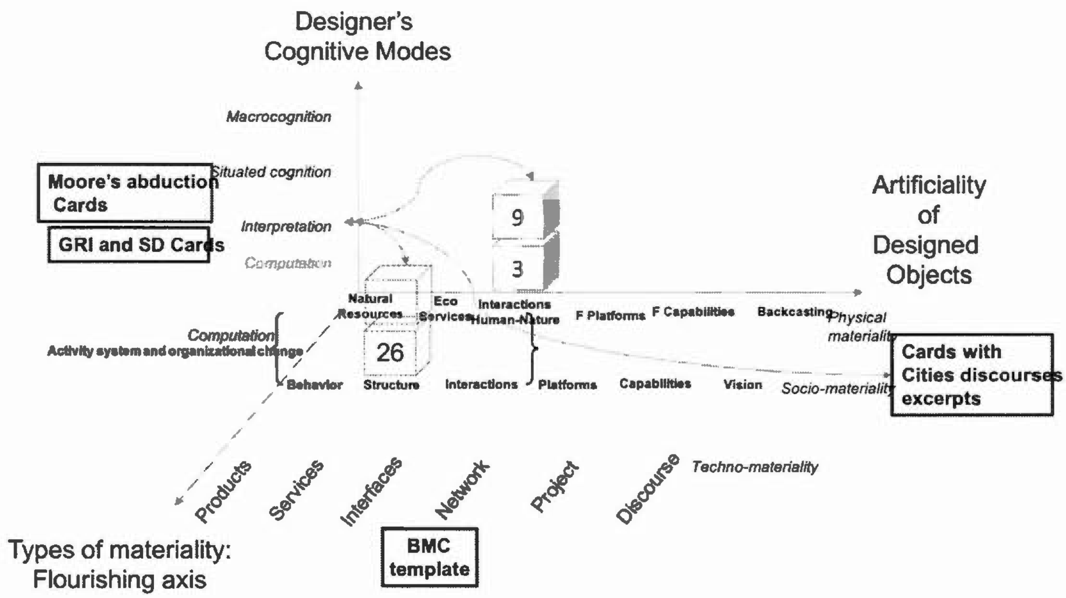


Figure 4.11 RR Player's Full Profile on Three Axes Model

> I understand that it's a game. But where I was disarmed by your game was in the total opposition between my six cards… the context of the city was in complete opposition to the political, technological and environmental discourses. On one hand, you have organizations that focus on a problem and then solve it, but the solution is not good and then the problem escalates, which inevitably leads to conflict (From RR).

4.4.2.3 TT—Playing a Canadian City

The TT player played outside the parameters of Moore's (2007) fieldwork. She had to take as a referent the Canadian city for which she works. No discourses were available, as discourse cards were blank, but she knew very well that contradictory discourses exist in the city around the issue of sustainability. Her strategy was to quickly focus on the BMC template and use it to propose a new way to plan a huge infrastructure project. Her BMC looked very complete (Figure 4.13), and her profile showed that she was exploiting her deep knowledge of city's activity system to work on a revised BMC.

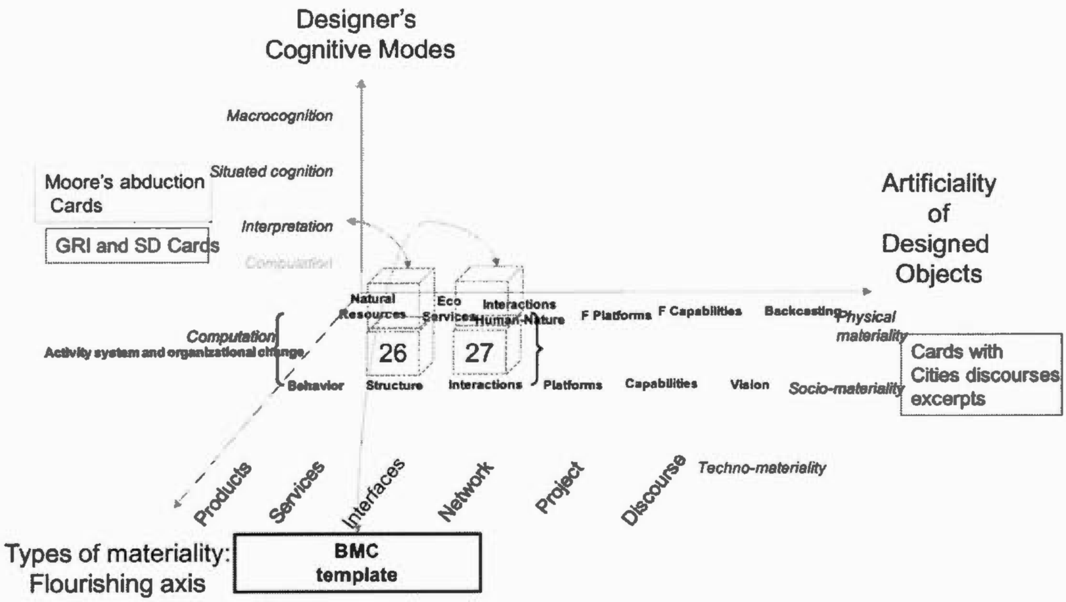


Figure 4.12 TT Player's Full Profile on Three Axes Model

So, I can tell you that in the exercise I could combine a bit of what I like as discourses with support cards. But, obviously, the Canadian city was not as well documented by precise discourses as were the other cities. So, I put together everything I thought was interesting as discourse. In BMC template performance, I reflected on the interchange, but I saw the BM framework as a reflection of the organizational sustainable processes... something more sustainable. Therefore, I questioned the structure of the BM framework that you had provided...the arrows from the left to the right. So, I kept the same blocks but I allowed myself to make a representation that seems, in the case of the interchange, a more sustainable process for the Canadian city. Therefore, this is what I did. /.../ I hit all the blocks, the nine blocks that you had set. I described a little in that project how I would see the way to go. It's clearly not something straightforward for me. I approached it more as a process. I see it as a project management process, in general, which is very comprehensive with these three areas. I find it the issue of new capabilities, values, trust and loyalty very interesting. I find it fun as well; these three blocks here are really interesting, and the rest seems a little more traditional as elements (From TT).

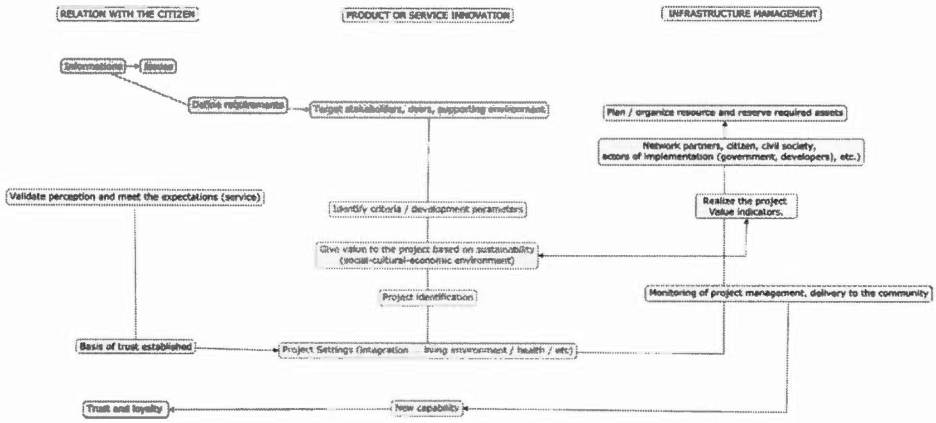


Figure 4.13 Transferring TT's Analysis onto the BMC Template

4.4.2.4 VV—Playing Curitiba

The VV player could not move in the game as freely as TT, who wasn't facing contradictory discourses. His cards illustrated Curitiba's discourses, but he first and foremost mobilized his knowledge from the Canadian city where he is working: "Ok, actually, I was struggling to imagine what was happening in Curitiba and trying to use my own referents at the same time." As a sustainability specialist, he is very fond of SD Brundtland's (1987) definition and tried to build his reasoning from his SD cards (Figure 4.15). Being very committed to sustainability, he didn't find BMC reporting or mapping an easy task (Figure 4.14.).

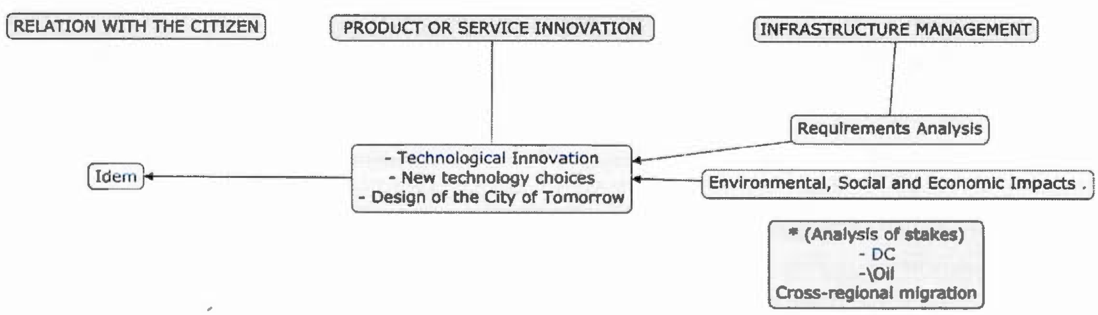


Figure 4.14 Transferring VV's Analysis onto the BMC Template

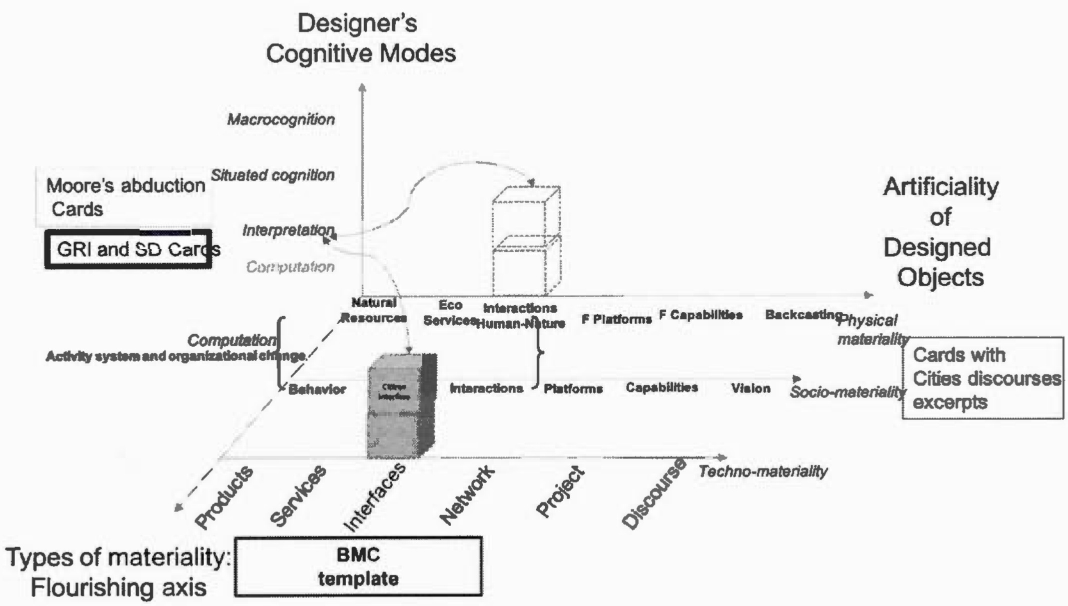


Figure 4.15 VV Player's Full Profile on Three Axes Model

Here, I have my sustainable development pillars (social, economic, environmental). I like to put forward an argument in support of each of the pillars. I have my little scheme of sustainable development, but I don't have the environmental dimension that I lack.

Ok. I was imagining myself in Curitiba while using my local referents at same time. The interchange project took me a while because I was reading the business model. I was reading, and I thought that our interchange project has probably been managed the way the BM template is presented. But...perception, trust and loyalty and service to citizens... You know that piece here obviously did not work, and I thought how do we go back? How does one go back to the relations component with citizens in the interchange project in order to make it better articulated, better formulated and more in line with citizens' needs (From VV).

4.4.3 Closing: Informal Group debriefing

In situated cognition, after embodiment and embedding, there is:

> …the claim that cognition is *extended*—the claim that the boundaries of cognitive systems lie outside the envelope of individual organisms, encompassing features of the physical and social environment (Clark & Chalmers, 1998; Wilson, 2004). In this view, the mind leaks out into the world, and cognitive activity is distributed across individuals and situations. (Robbins & Aydede, 2009: p. 8)
>
> …it becomes as important for cognitive modeling to track causal processes that cross the boundary of the individual organism as it is to track those that lie within that boundary. In short, insofar as the mind is a dynamical system, it is natural to think of it as extending not just into the body but also into the world. (p. 8)

As the mind leaks out into the world, it leaks outside the game boundaries. The gamestorming experiment with Logim@s© took place in one meeting room in a city building, in a room where the players were used to meeting each other in a work context. The gamestorming experiment was not a laboratory experiment, and the debriefing end period shows that all players went from individual debriefing about their BMC back to ongoing issues in their department… or back to work! First they all agreed that in the BMC applied to city sustainability management, it was not the infrastructure that created value to maintaining good relations with citizens. It was the reverse. The citizens should have the ability to decide what kind of infrastructure they want and can afford. From this agreement, they came back to issues at hand:

> But it happens with projects such as, for example, waste management in the territory. In this example, these are all infrastructures that act like little highway interchanges taken together. But is there an appropriate uniform model everywhere as there is for organic management? If a part of the territory could rely more on citizen participation, local organic waste management could be relocated everywhere over the territory because operators have large lots and we could decentralize compost production. In some areas, other solutions could

> be adopted. It would be as if we had distributed exchangers over the territory before going to public consultation. These are not unique solutions (From VV).

But situated cognition means not only 'being in an environment' but also using the environment for cognitive purposes (the environment is also part of the cognitive system).

Two things are remarkable here: the power of analogy and the real setting where the mind—in some way a collective mind—leaks out into the world. Hutchins, a master of 'cognition in the wild' studies once wrote:

> The phrase "cognition in the wild" refers to human cognition in its natural habitat-that is, to naturally occurring culturally constituted human activity. I do not intend "cognition in the wild" to be read as similar to Lévi-Strauss's "pensée sauvage," nor do I intend it to contrast with Jack Goody's (1977) notion of domesticated mind. Instead, I have in mind the distinction between the laboratory, where cognition is studied in captivity, and the everyday world, where human cognition adapts to its natural surroundings. I hope to evoke with this metaphor a sense of ecology of thinking in which human cognition interacts with an environment rich in organizing resources. (Hutchins, 1995: p. xiii-xiv)

4.4.4 TUTOR

In the Logim@s© context, this thesis' author was dedicated, on the one hand, to assisting players as they dealt with a new game concept (goal, game space, artefacts, rules of interaction etc.), and, on the other hand, to validate ideas, intuitions, strategies, definitions and general knowledge about the background of the game, i.e. city management and sustainability. Half of the time, the human tutor took part in the conversations between players. Along the way, he was asked to remind players what the interaction rules and goals were and to explain card statements. Surprisingly for a gamestorming context, he had to remain detached from the real professional stakes, as he needed to validate the reality of discourses discussed in the game. Here are a few examples of the type of questions asked: Is what I am reading about the Austin discourses true)? Another was: Who is really in charge of highway transportation in Frankfurt (Mayor, Land, Federal State)?

> One may wonder who the infrastructure manager is? Is it the Ministry of Transport, or do we have to go to a higher authority. And, then, is it someone who manages the general transportation of people, etc. After that, we could ask… is that the customer? Since there was a customer case here (...) Is it the driver? Or is it the citizen? Is it mobility, the engineers? Or is it the highway builder, hidden as a customer behind the infrastructure manager? (From OO).

4.5 Conclusion

The goal of this gamestorming wasn't to diagnose a logical mode applied as sustainability implementation. The goal was to use a BMC template to check how, from competing discourses, sustainability is 'introduced' in BM design. As indicated in the introduction, if the BMC approach does not seem very helpful for BMF design, this proposition needs to be tested. It is the *raison d'être* of chapter four. Not surprisingly, players used their own referents when reasoning about sustainability. The transcript indicates that the usual referents were the three pillars from Bruntland's model, even when a player was asked to develop strong sustainability. The use of lists like GRI wasn't current practice in the Canadian city. But the transcript also shows that some players inside the game's boundaries were able to build strong arguments from the meaning of Moore's 'OTHER' cards and use and apply an abductive approach to sustainability. This was a learning benefit for players who explored this way of reasoning and was also a step toward the development of 'social competence.'

Engeström & Sannino (2012) revised the work of some authors on "cognition in the wild," a topic broached by Hutchins. Among those authors, Engeström & Sannino (2012) quotes Vygotsky (1987) and his theory of double stimulation.

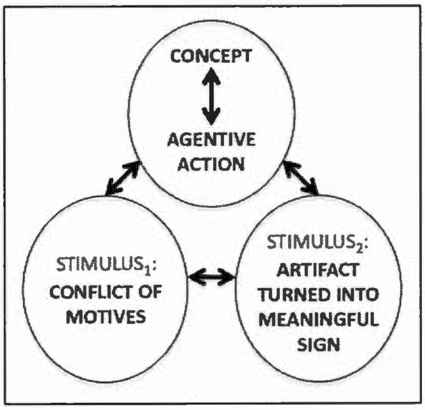


Figure 4.16 Vygotsky's (1987) Theory of Double Stimulation

In the theory of double stimulation, the initial stimulus situation involves a conflict of motives. The conflict is resolved by invoking a neutral artefact as a second or auxiliary stimulus, which is turned into a mediating sign by investing it with meaning (Figure 4.16.)./…/ In such a process of double stimulation, the formation of will and the formation of concept literally go hand in hand. It is essentially a process of reframing or recontextualizing a problem situation (Engeström & Sannino, 2012: p. 204).

Vygotsky's theory of double stimulation offers a new architectural view of the Logim@s© game. Originally conceived to move sustainability ideas, definitions and discourses into the BMC framework, it happens that the game is also a double stimulation toward building new BMF concepts. The fact that each city is presented with close to incompatible discourses generates tensions (which may block one player's reasoning ability) can be identified with *stimulus 1* in Vygotsky's theory. The support cards and BMC form, in this case, *stimulus 2,* are artefacts turned into a meaningful sign.

> I saw business models as a project management process in general, which is very comprehensive in the following three areas: infrastructure, value creation through innovation and relationships with citizens. I found interesting new capabilities, values and trust and loyalty categories. I found that very funny! These three blocks here were really interesting. The rest (discourses, SD, GRI) seems a little more traditional. It's just that I enjoyed myself. (From TT)

This player saw the BMC as a meaningful sign and sustainability conflicts as not so interesting. That's the game! This interpretation of the gamestorming experiment should help in the design of an intelligent tutor. "The suggestion that intelligent agents do best when they travel informationally light, keeping internal representation and processing to a minimum, informs a wide spectrum on research on cognition in the situated tradition." (Robbins & Aydede, 2009: p. 7)

Which raised an interesting question for the tutor too: Should the tutor know everything about sustainability, cities and business models and digest a lot of structured knowledge, or should the tutor be designed with a minimalist approac

CHAPTER V

SYSTEM DESIGN: FROM THE LOGIM@S© GAME TO THE SUSTABD© GAMESTORMING PLATFORM

5.1 Introduction

A BMF as an innovation emerges from interactions between fields of expertise and actors:

> The interesting point in this perspective of innovation is that we cannot identify a single system (person, etc.) being responsible for bringing forth an innovation. Rather it is the interaction between these domains and between the actors in these domains who are the source of innovation. Hence, we suggest understanding innovation as an emergent phenomenon: it is the result of a highly complex social and epistemological process with a meandering and serendipitous interaction history and it is not a deterministic process. (Peschl & Fundneider, 2014: p. 348)

Such an emergence follows interactions and activities that are happening at the fuzzy front end (Figure 5.1), the departure point of the innovation process where innovation represents a new product, a new service, a new customer interface or a new business model (Krippendorff, 2007). The fuzzy nature of front-end activities requires a gamestorming environment—rather than a serious gaming context—because these activities are defined by fuzzy goals (Gray et al., 2010). In anticipation of an open innovation world, Logim@s© should become an open gamestorming platform, let's call it SustAbd©, a portmanteau word for *sustainability* and *abduction*. In our

Logim@s© field test, players knew that they had to combine sustainability with BMC in the context of a specific city. But there is no best way to reach this goal; we are not in the standard context of a serious game with domain knowledge, expert knowledge, tutor knowledge and a precise learning goal to reach. In such a context, what is important in the designer's eye is an individual and social capacity (social competence) to generate new flourishing practices (F Practices).

"Among the most stable elements in a platform architecture are the modular interfaces that mediate between the platform and its complements" (Baldwin & Woodard, 2008). Modular interfaces aside, a platform has two parts: the core and the periphery.[38] Like the Linux kernel, the core is made up of essential modules used by the periphery. On an iPhone, iOS 8 is the core, and Apple apps form the periphery. Let's assume that the core of SustAbd © is a card game generator similar to the game experimented with and described in chapter four. The key is to supply the core with contradictory discourses that are congruent with *stimulus 1* from Vygostky's theory, as detailed in the conclusion of chapter four. Therefore, the core must manufacture electronic 'cards' that will successively illustrate *stimulus 1* and *stimulus 2*, which function as support cards following Moore's (2007) logic of deduction (SD definition by Brundtland in 1987), induction (GRI reporting) and abduction in the form of 'OTHER' cards.

What are the challenges of building a gamestorming SustAbd© platform? If abductive reasoning is one of the expected benefits for the players, it should be supported by a

[38] Platform architectures are modularizations of complex systems in which certain components (the platform itself) remain stable, while others (the complements) are encouraged to vary in crosssection or over time. Among the most stable elements in a platform architecture are the modular interfaces that mediate between the platform and its complements. These interfaces are even more stable than the interior core of the platform, thus control over the interfaces amounts to control over the platform and its evolution. We describe three ways of representing platform architectures: network graphs, design structure matrices and layer maps. We conclude by addressing a number of fundamental strategic questions suggested by a unified view of platforms. (Baldwin & Woodard, 2008)

kind of abductive engine like the proposed *Universal Abduction Studio*, which should lie at the platform's core.

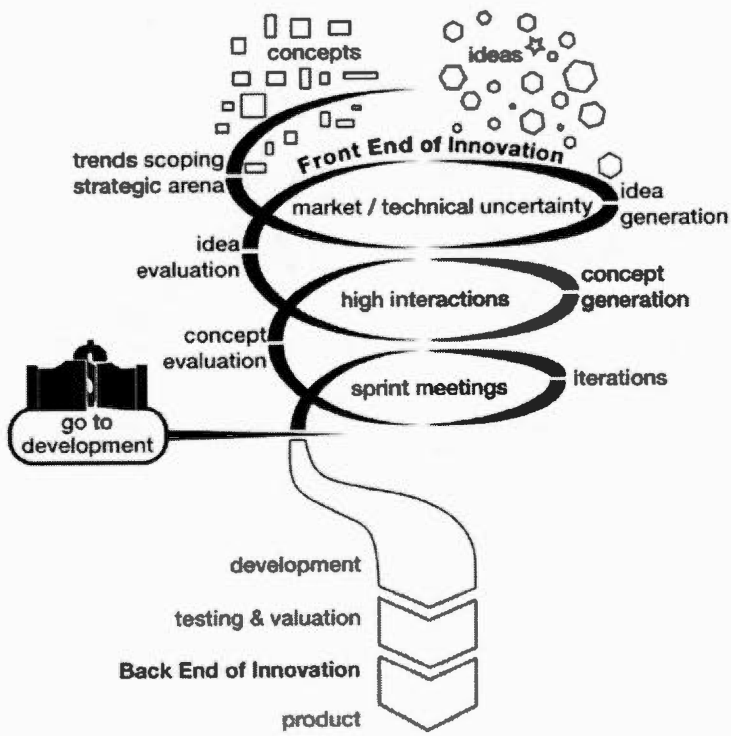


Figure 5.1 Activities at the Fuzzy Front End of Product Innovation

Source: Oliver Gassmann and Fiona Schweitzer (2014: p. 7)

Another part of the core is a gamestorming tutor that 'knows' the rules of interaction, the space of the game etc. A third part of the core is a knowledge base fed by users, players and experts.

At the periphery are cases, stories, companies, cities or 'place' storylines regarding the adoption of sustainability, in addition to facts, concepts, procedural and metaknowledge. In the same vein, these knowledge sources are formal ontologies like sustainability science ontology and business model ontology. The flourishing navigation process (F navigation) should start in the players' minds by backcasting followed by the identification and development of flourishing capabilities (F capabilities); these F capabilities should be organized as a multisided platform and generate new F Practices. Between platform definition and F Practices proposal, extant BMCs and BMF canvases can be interesting debriefing tools. However, the designer keeps in mind that the goal is not to build a new BMF template but to generate and develop new F Practices as defined in chapter one, following Nidumolu et al., (2009). We also keep in mind as designers that the gamestorming environment should be compliant to non-hierarchical conditions for macrocognition (Huebner, 2013), which allows players to combine their arguments to generate F Practices.

This chapter has two parts: the first part is a reflection on the game design process in order to justify a platform-architecture approach made up of the SustAbd© core and the SustAbd© periphery, and the second part proposes five out of seven key UML use cases.

5.2 Game Design Process for Gamestorming about F Practices

Jonassen (2011) identified eleven different kinds of problems.[39] As two major components in problem solving are problem representation and problem solution (Anderson et al., 2001: p. 65), Jonassen (2011) reflects on the nature of these different problems and the cognitive effort required to solve them. His contribution is to bring forward propositions to design and build adequate intelligent environments for problem solving in each case. Design is the most complex and poorly-structured

[39] They are: 1. Logic problems, 2. Algorithms, 3. Story problems, 4. Rule-using/rule-induction problems, 5. Decision-making, 6. Troubleshooting, 7. Diagnosis-solution problems, 8. Strategic performance, 9. Policy-analysis problems, 10. Design problems and 11. Dilemmas.

kind of problem solving (Jonassen, 2011: p. 138). Game invention requires design, but this kind of design is not the same as the engineering or mechanical kinds. For Jonassen (2011: p. 145), design is also a process of model building. As design decisions are made, designers begin to construct sketches that morph into models that morph into prototypes. And further: "The goal of design is satisfying, not optimization." Modeling is the key tool in supporting the design activity.

Smith (2009), in his quest for an intelligent game designer, made a distinction between game level (artefacts), play level (strategies) and design level (game invention) (Figure 5.2). Smith comments thus:

> What does such a system imply for the relationship between discovery and expressive domains? Concretely, this translates into a more direct question when looking to examine game design: How can game design be re-conceptualized to make it into a suitable domain for discovery? An answer to this question should also answer several related, lower-level questions: What are the discovery activities in game design? What do conjectures apply to? How are experiments carried out (in terms of environments, observations, and instruments)? How are conjectures verified? And is there a sense of proof in game design that mirrors that of mathematics? Looking to re-examine discovery, there is the reverse question: How can discovery be re-conceptualized to make it applicable to game design? (Smith, A.M., 2009: p. 4)

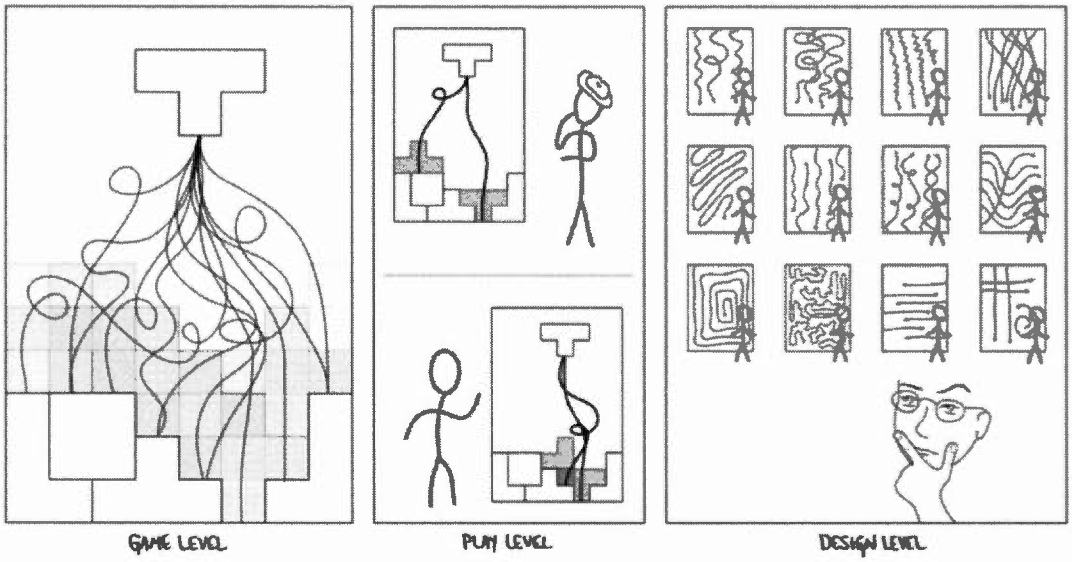


Figure 5.2 A Visual Mnemonic for the Levels in Smith's Game Design Metatheory

Source: Smith, A.M. (2009: p. 23)

This excerpt from Smith (2009) connects the funny side of gaming with discovery and science and allows us to reinterpret this thesis' objective. How can gamestorming design be re-conceptualized to make it into a suitable domain for discovery, and more precisely into a platform for the discovery of F Practices, following Nidumolu et al. (2009) and other authors? The first step in conceiving the SustAbd© platform is to revise Smith's game design levels through the lens of cognitive sciences.

5.2.1 BM as Cognitive System: How BM Decomposition Fits the Cognitive System Levels

A traditional cognitive system is made up of three levels: representational, functional and material. At the representational level, data, information and knowledge are accumulated in people's heads and digital systems like the KB (Knowledge Base).

At the functional level, organizational policies, standards and methods, business rules and other managerial decisions are functional algorithms to be implemented at the material level through organizational routines, communication channels and organizational culture, as the body implements mental algorithms. Viewing the BM design process as a 'traditional' cognitive system highlights similarities between the three cognition levels (representational, functional and material) and the three main BM components (theme, revenues/expenses architecture, activity system), as defined by Zott & Amit (2010). At first glance, the material level can be equated with activity system, the functional level with business architecture that generates revenues/expenses and the representational level with BM themes and associated knowledge, discourses and arguments.

5.2.1.1 At the Representational Level

A previous chapter mentioned Perkmann & Spicer (2010), who wrote: "[B]usiness models are performative in three ways: as narratives that persuade, as typifications that legitimate, and as recipes that instruct."

5.2.1.2 At the Functional Level

As we mentioned earlier knowing internal and external invariants will help to design essential functions for system maintenance: "[F]unction is used to express the role of an activity of a unit for the maintenance of the system of which the unit is part. This is called the 'activity function'"[40]. One way to model the invariants is to build an ontology leading to a BM canvas like the Osterwalder and Pigneur canvas shown in Figure 5.3.

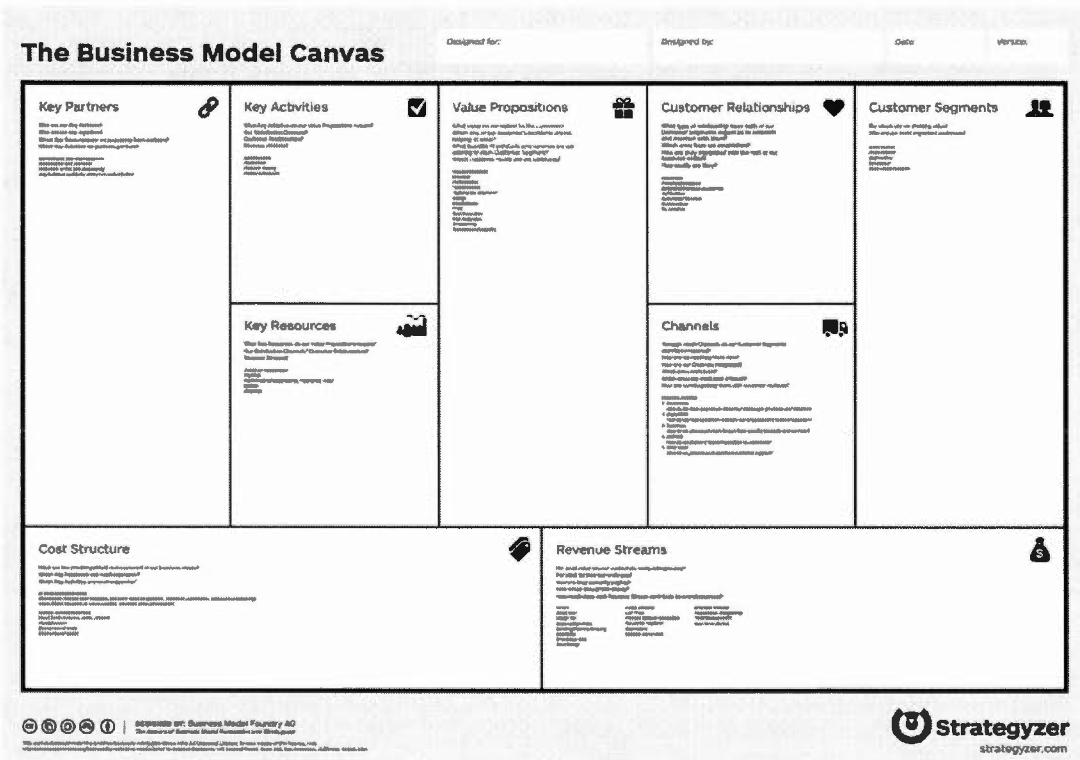


Figure 5.3 The Osterwalder-Pigneur BM Canvas

This canvas does not consider the actor's preferences; only nine super categories define a BM. The main functions that can be derived from the canvas are input management with key partners, key activities leading to a value proposition and distribution to customers' segments through customer relationships, with each activity generating revenues and/or expenses. Another meaning of function is teleological in nature; it is the "goal supporting view of function," where an agent acts with a goal reaching intention (Garrett Millikan, 1984; Neander, 1991). Again,

[40] Meunier, J-G. (2008). Notes de séminaire DIC 8101.

the actor's functions are not mentioned in the canvas, but key BM functions appear to be sourcing, partnering, designing, distributing and computing revenues/expenses.

5.2.1.3 At the Material Level

For Zott & Amit (2010), a BM activity system is made up of three elements: content, structure and governance. For the authors, content refers to the selection of activities, i.e., those that are performed; structure describes how the activities are linked (e.g., the sequencing between them), and it also captures their importance for the business model (e.g., in terms of their core supporting or peripheral nature); governance refers to who performs the activities (p. 220). Due to the socio-materiality of activity systems, the activity system is only approximated in the BMC through abstract ideas about activity architecture.

5.2.2 The Three Levels in a Cognitive System

The BMC exists only at the representational level in order to capture the required data to complete seven main categories and to compute costs and revenues at the functional level. The BMC has no material level, and we developed this point in previous chapters when we expressed the need for socio- and physical materiality.[41]

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[41] The BMC has no material level only if it is considered in isolation of the connected pieces of the BMC practice, so for example the VPC mentioned earlier, the process of evaluating multiple possible BMs for selecting the optimal one and the development of the business plan related to a selected BM. To ignore those connections and the multiple levels of the BMC process while expanding on similar connections for other considered models does not provide an objective comparison. It could also be argued that the extant BM embodies the representation level reflecting the knowledge accumulated in peoples' head as well as in institutional memory of various forms. (Evaluation note by Nabil Harfoush)

A key distinction between BM and strategy concepts is that strategy is generally discussed in terms of strategy formulation/strategy implementation, where knowledge maintains close interaction. Without the material level, a BM conceived on a BMC is abstract. When games are played, they embody the three levels of a cognitive system.

Material Level Functional Level Representational Level

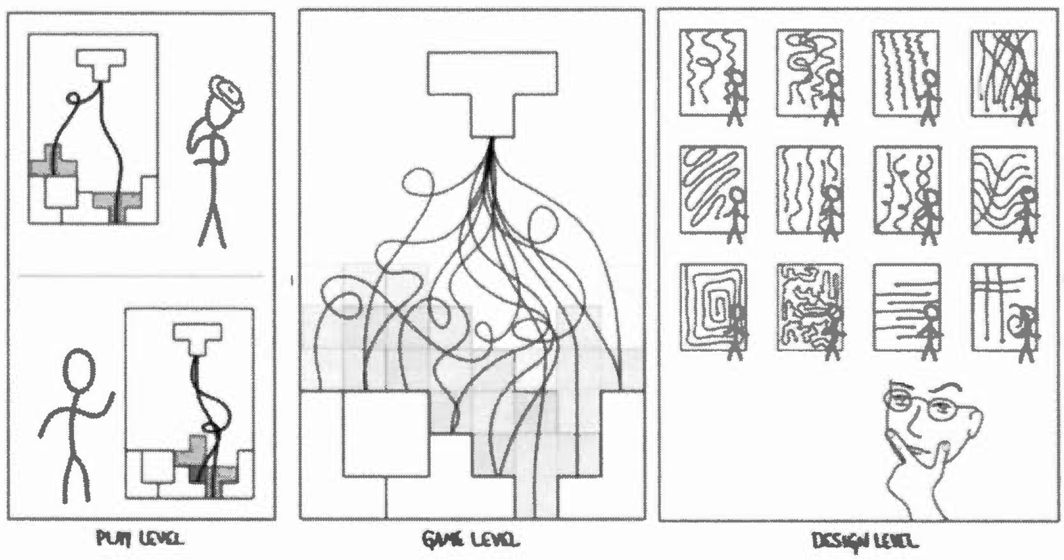

Figure 5.4 Game Design as Cognitive System

The richness of game developing lies in play level; the designer(s) will get feedback from the material level. These three levels can be reinterpreted thanks to the contribution of cognitive sciences (Figure 5.4).

We examine, in succession, some of the preconditions to design (at the representational level), to the game (at the functional level) and to play (at the material level).

5.2.2.1 Design: Gamestorming F Success Conditions

At the representational level, an idea for a new cognitive artefact starts in the designer's head to facilitate our always-more-sophisticated activity (Paavola & Hakkarainen, 2005). There are myriad options because they come from very different disciplines, are of a different nature (factual, conceptual, procedural, meta) and become available to knowledge workers who are sometimes in a knowledge-creation or a knowledge-use posture.

We are working in complex and heterogeneous networks that consist of humans and various artefacts (see Latour 1999). To facilitate our more sophisticated activity, we are creating and using cognitive artefacts that are more knowledge-laden, smart and autonomous. Knowledge and related concepts, such as expertise and intelligence, increasingly define our activity in the knowledge-based society. To conceptualize and understand the nature of work and activity in this society, one has to learn to understand the various types of knowledge and how they are used and made to grow. In other words, a kind of epistemological shift is needed within teachers, educational psychologists, cognitive scientists, students, and all other participants interested in developing the educational. (Paavola & Hakkarainen, 2005)

Designing a cognitive system facilitating the production of F Practices must be different from designing a BMC gamestorming. The production of F Practices has as a precondition a will to 'Get there' and a knowledge-use (instead of creation) challenge when facing backcasting cognitive processes. For example, in the healthcare system, Davies et al. (2016) see three main types of research use:

• **Instrumental/ direct use:** Applying research findings in specific and direct ways to influence decision choices.

• **Conceptual/ indirect use:** Using research results to change understanding or attitudes, including introducing new conceptual categories, terminology or theories.

• **Symbolic/ political/ persuasive use:** Using research findings to legitimise and maintain predetermined positions, including the "tactical use" of research, for example, justifying inaction while awaiting further study.

In our view, backcasting implies instrumental/direct use, but for the authors all three uses will be seen simultaneously. Davies et al. (2016) recall the Weiss (1979) typology defining seven ways where research based knowledge may be used: 1. Knowledge driven. 2. Problem-solving. 3. Interactive. 4. Political/symbolic. 5. Tactical. 6. Enlightenment. 7. Societal.

Moore (2007) gives some knowledge-use tips with his 'abductive' sentences and so does Goleman. According to Goleman (2009), it seems that companies no longer have a real choice about whether or not to change their logic; consumers develop *ecological intelligence* that requires total transparency in the composition of products and manufacturing processes.

For Goleman (2009), *the consumer is now in a position to know the impact of any purchase on the environment*. He gives the example of the website *Good Guide* where consumers continually assess the ecological quality of purchased products. For Goleman, the expression of ecological intelligence extends the ability of native naturalists *to categorize and recognize patterns* in sciences such as chemistry, physics and ecology, using the lens of these disciplines in dynamic systems operating at different scales, from the molecular level to the planetary scale. This knowledge of how things and nature work includes the recognition and understanding of the myriad ways with which artificial systems interact with natural systems. This new awareness allows us to read the interconnections between our actions and their impact on the planet, our health and our social system. In fact, understanding sustainability is a scientific challenge (Antal & Hukkinen, 2010), which requires an understanding of new concepts such as biosphere, ecological footprint, climate change, sustainability science etc. In other words, it is a knowledge-use challenge:

In contrast to the myths and stories of ancient peoples, *the underlying knowledge and reasoning of contemporary societies is grounded in science.* Of course, not everybody can be expected to mobilize complex, science based belief patterns prior to every environmental management decision. Instead, we deal with our cognitive limitations by condensing real world complexities into simple conceptual blends that capture their pragmatic relevance (Antal & Hukkinen, 2010: p. 241). (Emphasis added)

BMF and F Practices productions will come through more transparency among decision-makers, consumers and local communities.

5.2.2.2 Macrocognition Principles

Gamestorming must fit macrocognition conditions, insofar as 'travel with others' is the new 'name of the game' for sustainability development.[42] This is exemplified in the January 2015 MIT Sustainability Report:

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[42] "Almost one-third of the global economy passes through a thousand large companies and their extended network of suppliers and partners: In 2012, the world's largest 1,000 companies generated $34 trillion in revenues. By comparison, the entire gross world product was $85 trillion in 2012. With 73 million employees, the global 1,000 commanded some 50% of the world's market capitalization in 2012. According to the UNEP Finance Initiative, "the Global 1,000 can now influence billions of people around the world, from employees to suppliers, customers and even regulators."34 With such enormous influence, however, comes equally daunting vulnerability. "We are at a critical juncture — economically, socially and environmentally," United Nations Secretary-General Ban Ki-moon has said in public remarks. "More than 1 billion people lack access to food, electricity or safe drinking water. Most of the world's ecosystems are in decline. Gaps between rich and poor are widening. Climate change and population growth are expected to compound these challenges. The threat to prosperity,

> For many companies, it is simply not enough to manage for such risks with scenario planning and other risk management tools. Many businesses are realizing that they need to change the risk vectors at their source if they are to avoid such material risks to their corporate strategies and their long-term future. No single company can surmount these risks by itself. As our research found, *the path to sustainable success is travelled with others.*[43] (MIT, 2014, p. 17-18). (Emphasis added).

Travel with others means more than the quest for a BMF for companies and managers; it means the quest for a sharing platform that enables managers and professionals to envision and define new F Practices. If value creation and capture is a domain reserved for strategists, sustainability should be open to macrocognition (Huebner, 2013). Collective 'green' behavior should not result from an organizational structure set up to achieve the goals or realize the intentions of a few powerful and/or intelligent people. Instead, an open platform should work as a community of practice. The second condition adapted from Huebner (2013) states that 'green' collective behavior cannot bubble up from simple rules governing the behavior of individuals. This is a tricky condition for a game designer because interaction rules must be precise to generate a new game space. But both literature (Torres & Macedo, 2000) and experience indicate that the end of game debriefing period brings fruitful dialogue and develops social competence, creating a climate suitable to the generation of F Practices. Finally, for Huebner (2013), macrocognition cannot exist where the collective computations are no more sophisticated than the computations that are carried out by the individuals who compose the community. We adapt this principle to our platform design by balancing individual and collective

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productivity and our very stability is clear. Market disturbances, social unrest, ecological devastation, and natural and manmade disasters near and far directly affect your business — your supply chains, capital flows, your employees and your profits."

[43] Joining Forces Collaboration and Leadership for Sustainability The growing importance of corporate collaboration and boards of directors to sustainable business By MIT Sloan Management Review, The Boston Consulting Group and the United Nations Global Compact (January 2015).

computations. Individuals play Logim@s©, but it is the group that is induced in open debriefing exchanges where new F Practices can be proposed and defined.

5.2.2.3 Situated Cognition Conditions

How is it possible to think about a cognitively situated gamestorming platform? The first answer that comes to mind is by connecting it to interactive cyberinfrastructure where human thoughts are connected with physical materiality much in the same way oceanographers are connected interactively with physical resources so that physical environment can become a part of individual and group cognition processes. An intelligent system learns during its existence. It interacts with its environment and learns, in each situation, which actions enable it to achieve its goals. An intelligent system acts continuously both 'mentally' and 'externally.'

Take the example of a computer system dedicated to oceanographic observation, the 'LOOKING' system:

- The system exists within its borders. The *'Laboratory for the Ocean Observation Knowledge Integration Grid'* (LOOKING) developed a cyberinfrastructure that must harness the physical resources to combine real-time sensor networks with predictive modeling services using computerized analytical services.
- The system interacts with an identifiable environment. LOOKING must behave like a network of integrated, autonomous sensors that can evolve and adapt to changes in user priorities, available technologies, changes in software and also in the physical environment during the expected life cycle for this observatory. It receives information from the environment to develop a current situation in the representative.

The first component of the LOOKING network is 'to sense.' Components of the 'sensing' function are sharing with distributed devices, at sea or on land. The second component is the 'deliberation' or decision analysis that occurs when a new event is identified. This action connects data capture to system responses. The third component is the action that allows the system to respond to a given event. To achieve its objective, the intelligent system selects an answer. In the case of LOOKING, this response may be up to change sensors. The system is capable of learning by selecting one of the favourable responses to the situation. The system is able to act by performing the selected answer. Intelligent River Project[44] is another case of intelligent cyberinfrastructure:

Imagine that a river could talk. Imagine that it could convey its condition to the people who manage the water flow needed for drinking water, hydroelectric power, recreation and industrial production. Imagine an *Intelligent River*. Water flows. So does information. Water resource managers need to know immediately—not days or weeks later—if there is a dangerous change in water temperature, oxygen levels, flow-rate or chemical make-up. Imagine a system that reports this information as it's happening. That vision is being realized today by the *Intelligent River Project* at Clemson.

The implications for the envisioned BMF platform starts with ecological value, not business value. There must be a 'place-based' ecological value at stake putting stakeholders in a situated cognition posture. It is easier to observe that phenomenon inside city limits where water is polluted (like the Flint water crisis) or First Nations territories facing a pipeline project. Large corporations are freed from 'place' constraints; they will move away in case of lack of resources, high pollution rates and social protest. But, in the end, a F Practices exchange platforms should fit the limits

[44] http://www.clemson.edu/public/psatv/env/intelligent-river-overview.html, visited March 29, 2015.

of a business ecosystem encompassing multiple 'places' with their specific stakes. Sustabd© design should support, for one business ecosystem, interactions of different players trying to build distinct F Practices related to the 'places' composing the business ecosystem.

5.2.2.4 How to Functionally Change the Game? Good Stories

Twenty years ago, Kerney (1994) underlined the difficulties of sharing information aimed at improving environmental problems:

> Information aimed at encouraging conservation behavior and improving environmental problems associated with global change has been largely ineffective. The typical informational approach to these issues that are highly abstract, happening on a huge scale and can't be experienced directly has been to provide people with text that is highly abstract (e.g., providing scientific estimates of average expected temperature changes due to global warming), huge in scale (e.g., the number of species lost yearly, the number of forested acres lost daily) and not directly related to daily experience (e.g., widening gaps in the ozone layer) (Kearney, A.R., 1994: p. 419).

She insisted that the best solution was to develop good stories:

> *The only viable solution is to create texts that take advantage of the reader's natural processes and thereby facilitate learning.* A good story (case-study or analogy) is particularly compatible with the way people process information; it is one way to effectively communicate information about global change. (Kearney, A.R., 1994: p. 419) (Emphasis added)

Good stories for Logim@s© were found in Moore's book (2007). Those are convincing stories that analyze how city stakeholders, managers and leaders make sustainability a part of a city's identity. Leadership, in sustainability, is a key success factor as in BM innovation (change leadership). Two urban sustainability aspects are underlined by Moore (2007): environmental identity and environmental leadership.

Changing the Logim@s© game can be done by entering new convincing stories, stories that come from large cities or businesses from different countries or by examining the data behind the mayor of Saguenay's declaration, which called on citizens "to mobilize against Greenpeace and the intellectuals of this world."[45]

5.2.2.5 Play: Cognitive Load, Abduction as Logical Mode and Confusion as Syndrome

The mark of an expert in the ill-structured problems that occur in dynamic, uncertain and changing environments is to apply a set of tactical activities under time pressure. Real-time action means improvising and constructing new tactics while maintaining situational awareness (Jonassen, 2010). These strategic-performance problems are close to naturalistic decision-making and tactical decision-making under stress (TADMUS); they also imply a certain level of experience (Jonassen, 2010: p. 107). For Klein (1993, 1997, 1998), quoted by Jonassen (2010), expert problem solvers typically do not consider alternative options; they see each situation as a prototype they have seen before, an approach that is compatible with abduction. They recognize patterns of symptoms from their prior experiences referred to as event schemas or scripts (Schank and Abelson (1977) quoted by Jonassen (2010: p. 109)).

Solving these problems is well illustrated in the critical decision analysis that includes the following:

- Eliciting an incident
- Timeline verification and decision point identification
- Progressive deepening and the story behind the story

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[45] (*The Gazette* website, March 13, 2015)

- Checking for 'what if?' expert-novice differences (Jonassen, 2011: p. 113)

Following Jonassen (2010), expert decision-making is unconscious. To train novices, the primary method is to expose trainees to situation assessment through a simulation. In the same logic, sustainability science is a science built around 'place-based' problems to be solved. In this sense, it is related to cognitive science because it looks for a way to help think about the environment. Moore (2007) has worked on defining the logical steps by which pressure groups and city managers eventually implement all or some aspects of sustainability. Again, following Moore (2007), the logic of managers is based on the definitions of sustainable development such as that found in the Brundtland Report (1987), which falls into the category of logical *deduction*; managers who are founding their sustainability initiative in environmental *reporting* standards are in a process of *induction*, and managers who trust their common sense have limited means and say "*Let's see what works*" in a logic of *abduction* by formulating a new hypothesis. In fact, models and lists of sustainability are produced by social scientists that have studied the past through rational methods of deduction (models) and induction (lists).

However, planners and urban planners—in the study by Moore (2007)—seem to be much more productive than social scientists, *generating a sustainable future* using abduction as design logic. Moore (2007) recounts that they worked locally and were looking to the future—in backcasting mode—rather than universally and back. Thus, abduction is a situated logic by which designers and citizens become responsible for what they learn to visualize. Even if sustainability and sustainable development are founded on early definitions (Brundtland 1987) and reporting practices (GRI), there is solid common ground in sustainability science, innovation management (effectuation) and various field studies to propose abduction as the preferred logical mode to select actions for sustainability.[46]

In our theory, the core part of design, i.e., creating a new idea or thing can be attributed to "abduction" while ensuring design to deduction. Abduction is thus the crucial part in design. What is abduction, and what can abduction offer as reasoning? Abduction, as proposed by C.S. Peirce, is a logical process to find an axiom from a theorem. The naïve interpretation is that abduction is an opposite process of deduction. Although this naïve interpretation is somewhat popular within computer science, abduction should be interpreted from wider viewpoints and therefore include more various types of reasoning (Takeda et al., 2003).

We saw a case of confusion, blockage and frustration in our field experiment; we had at that time no experience or procedure to detect and resolve this type of impasse (Figure 5.5). According to D'Mello et al. (2014), this impasse can be interpreted as a signal of deep learning and in some way as proof that the gamestorming experiment was challenging:

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[46] This is true even if induction methods (such as measuring and reporting) may be needed to verify the direction of change achieved with the abduction methods, and deductive methods may be needed to assess whether the desired goal has been achieved or not. (Evaluation comment by Nabil Harfoush)

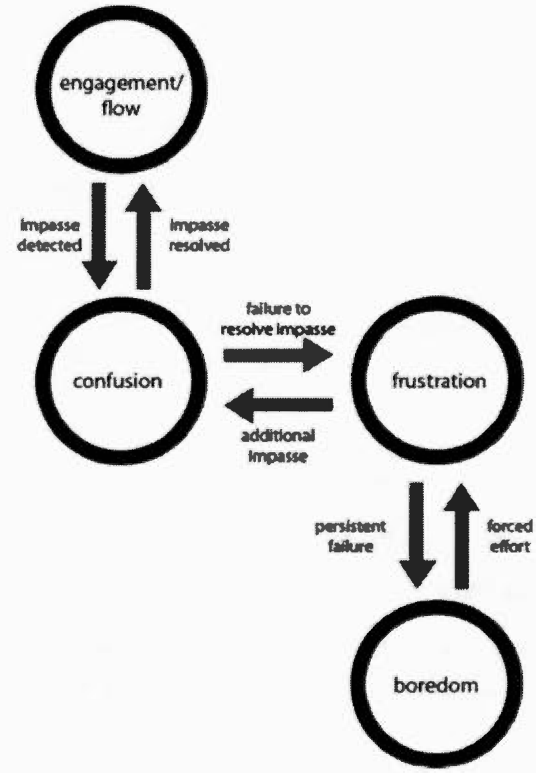

Figure 5.5 Observed Emotional Transitions and Their Hypothesized Causes

Source: (D'Mello et al., 2014: p.167)

> However, it is unlikely that confusion can be avoided for more complex learning tasks, such as comprehending difficult texts, generating cohesive arguments, solving challenging problems and modeling a complex system. Complex learning tasks require learners to generate inferences, answer causal questions, diagnose and solve problems, make conceptual comparisons, generate coherent explanations and demonstrate the application and transfer of acquired knowledge (Graesser, Ozuru, & Sullins, 2010).

This form of deep learning can be contrasted with shallow learning activities (memorizing key phrases and facts) and simple forms of procedural learning. *Confusion is expected to be more the norm than the exception during complex* *learning tasks*. Moreover, on these tasks, confusion is likely to promote learning at deeper levels of comprehension under appropriate conditions, as discussed in more detail below (D'Mello et al., 2014) (Emphasis added).

For D'Mello et al. (2014), "the importance of disequilibrium, impasses, dissonance, and conflict in learning and problem solving has a long history in psychology that spans the developmental, educational, social, and cognitive sciences" (p. 166).

5.3 SustAbd© as a New F Practices Generating Platform

The design and development of intelligent systems are difficult activities in computer engineering: 1) in the design, the specifications of the system are evolutive and difficult to stabilize because of the transdisciplinary nature of the work required at this step, and 2), as a result of the design stage, many elements thus remain implicit, which increases the complexity of the development process (Figure 5.6). Intelligent systems are systems with a capacity to acquire and apply knowledge in an intelligent manner through their perceptual abilities, reasoning, learning and by making inferences or decisions from incomplete information. 'Intelligent' here therefore means 'autonomous' and/or having an adaptive capacity such that the move towards a more efficient configuration is possible; the term 'system' here translates the association of process, technology and software interactions to be mastered together. A wide variety of these systems were designed, developed and implemented in engineering, science, medicine, law, business, agriculture and education (Karray & Silva, 2004).

The transition from procedural technology, object technology and what today we call model engineering has triggered a radical change in the way of considering information systems, conducting operations development and maintaining software engineering. The aim of software engineering is to provide a first-class status to models and model elements. The main change comes from the fact that the models are not only a document to guide programming activity but can be used to power the automatic software production tools (Bézivin, 2004).

A model is a possible representation of a system that allows for the study of a particular system's properties and, in some cases, can predict future outcomes. Models are often used in quantitative and technical analysis, and sometimes even in fundamental analysis, as in particle physics. According to Stachowiak (1973), a model has three characteristics: 1) an application characteristic where the model is based on an original; 2) a reduction characteristic where the model reflects a selection and 3) a pragmatic characteristic where a model can be used instead of an original that meets certain goals. Therefore, a model is a theoretical projection, a simplification of the world.

In the model-driven approach, the basic principle is that 'everything is a model.' The SUS (System Under Study) is captured by a model, and each model is written in the language of its metamodel. A metamodel is 1) a model that defines the language that expresses the model, and 2) a model of the language model. Seidewitz (2003) proposed the most commonly accepted definition of a metamodel. It is a specification model for a class of systems under consideration (SUC) in which each class is itself a valid model expressed in a modeling language. Therefore, a metamodel makes statements that can be expressed in valid models in a modeling language. For example, the UML specification document is a metamodel for UML, meaning that it includes a set of statements that should not be false to any valid UML model. This metamodel in its entirety includes concrete graphical notation, UML abstract syntax and semantics.

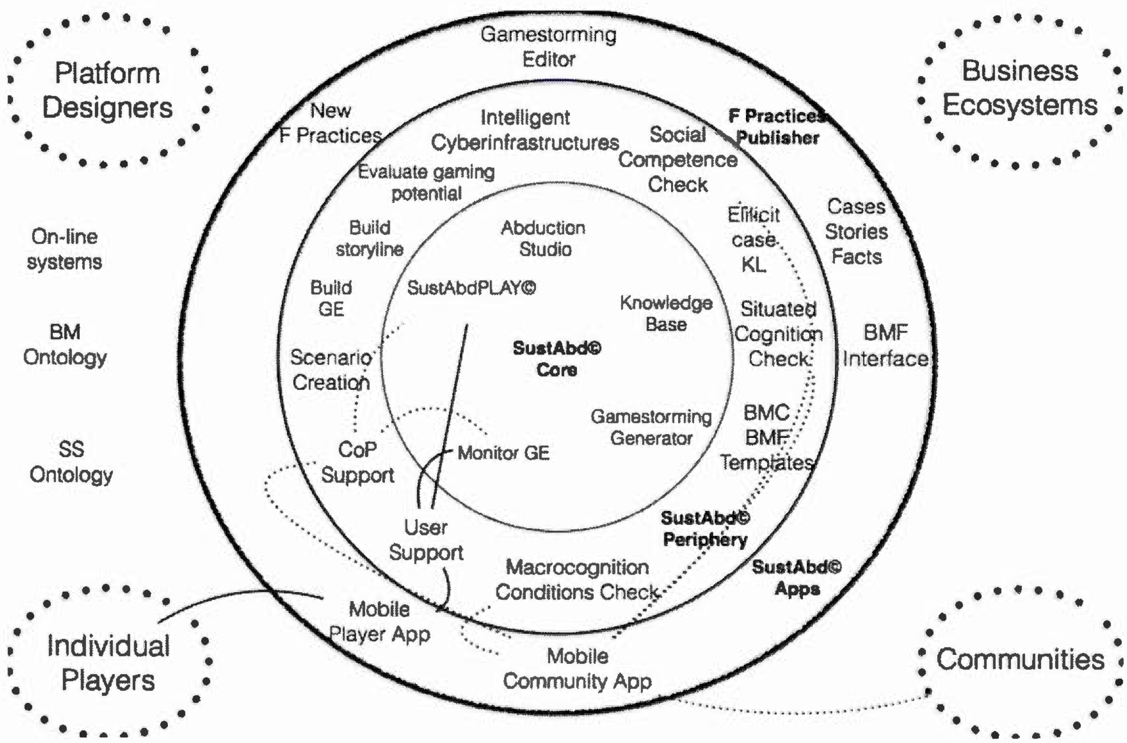

Figure 5.6 A System Design for the SustAbd© Core and Periphery Architecture

Figure 5.6 presents a possible system design for SustAbd©. It can be thought of as an open platform supporting mobile use. Some communities or team (i.e., people developing a sustainable BM) members could check for their group cognition conditions, find game partners in other business ecosystems and play assisted by applications like Play—and Game Tutors.

5.4 Five Main UML Cases to Develop SustAbd©

Main steps for UML case development are borrowed and adapted from Moore (2007) and Jonassen's (2011: p. 113) recommendations:

- Eliciting an incident by gamestorming designer: For example, in a YouTube video, Saguenay's mayor Tremblay accuses environmentalists of hindering local business, especially in the forestry sector.
- Timeline verification and decision point identification: More information and knowledge is brought by designer to enrich game space.
- Progressive deepening and the story behind the story
- "What if?" expert-novice or designer-player differences, decisions and more

Thus, we chose to create following UML cases:

- UML Case 1: Evaluate gaming potential of a place-based event/period with incompatible sustainability discourses.
- UML Case 2: Find or build a first local storyline.
- UML Case 3: Elicit case knowledge using FAC (Flourishing—Artificiality—Cognition) grid.
- UML Case 4: Built a gamestorming experiment (GE).
- UML Case 5: Monitor a gamestorming experiment (GE).

5.4.1 UML Case 1: Evaluate Gaming Potential of a Place-based Event/Period with Incompatible Sustainability Discourses

An example from *The Gazette*, March 13, 2015:

> On Tuesday, Tremblay made headlines for calling on citizens 'to mobilize against Greenpeace and the intellectuals of this world.' In a YouTube video, he accuses environmentalists of hindering local business, especially in the forestry sector.
>
> He referred to a drawn-out battle between environmentalists and the papermaker Resolute Forestry Products. Just over a week ago, Resolute said it was scaling back production and cutting 85 jobs at its plant in Alma, 60 kilometres northwest of Saguenay, because of poor market conditions, 'exacerbated by … the misinformation campaigns by Greenpeace and other environmental activists.'
>
> Greenpeace has been pushing Resolute's clients to switch to greener suppliers certified by the Forest Stewardship Council, a Bonn-based non-profit that promotes the responsible management of forests.
>
> According to Greenpeace, Resolute's logging threatens Quebec's slow-growing boreal forest, a crucial caribou habitat, and runs roughshod over the rights of First Nations.[47]

5.4.1.1 Use Case 1 Description

Use Case 1: Evaluate gaming potential of a place-based event/period with incompatible sustainability discourses

Actors:

Online news and newspapers, online books and magazines

GD (gamestorming designer)

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[47] (The Gazette Website, visited March, 17 2015)

Goals:

1. Identify event with incompatible discourses: dominant and alternative.

2. Check how discourses fit into game artefacts: cards.

3. Check validity of support cards

Trigger: GD (gamestorming designer) identifies sustainability event loaded with incompatible statements.

Type: Essential

Events Flow:

Table 5.1 UML Case 1: Events Flow

Actors' Actions	System's Answers
1. The GD creates a gamestorming event (e.g., Resolute case 01) and enters data about an identified sustainability event loaded with incompatible statements.	2. The system crawls news information websites to collect more data and send back web links and offers a list of table game types available.
3. The GD chooses Logim@s© type of game.	4. The system presents artefacts to be completed.
5. The GD is ready to complete artefacts.	6. The system asks to identify the four card series to stakeholders for the defined event.
7. The GD defines four stakeholders (Greenpeace, Resolute Co., Forest Stewardship Council and the Mayor) and attributes a card series to each.	8. The system creates the ecards with stakeholders' names and asks to complete political discourses statements on the Ace and King cards for each stakeholder, followed by environmental statements (Queen and Jack) and technological statements (10 and 9).
9. The GD keys in discourses significant abstracts.	10. The system presents default cards to support individual reasoning: sustainable development definitions, GRI definitions and 'OTHER' cards based on Moore's (2007) abductive statements.
11. The GD agrees to use default cards.	

Alternative flows:

The GD chooses another table game.

The GD wants to modify the Logim@s© support cards.

5.4.2 UML Case 2: Find or Build a First Local Storyline

Once incompatible statements are identified by SustAbd©, they can assist a GD in building a background to the case or a storyline in the words used by Moore (2007). From the Resolute case described in *The Gazette*, a quick Google search will lead to deeper contradictory discourses and analysis over a defined period of time. The GD quickly sees how Resolute Co. develops its position on a blog; Greenpeace offers an analysis on Resolute's responsibilities, while the Montreal Economic Institute shows that the condition of forests in Quebec is getting better and better. At different universities, master's and Ph.D. theses are being written about the actions and practices of forest companies against the caribou and the people of the First Nations. A new stage in the local storyline is rapidly emerging.

> Like triangles and tripods the notion that sustainability is best understood as a narrative is not a new one. David Nye (1997), Barbara Eckstein (2003), James Throgmorton (2003), and others have developed this idea over the past ten years. From their work we understand that all societies construct stories about themselves. We do so not only to distinguish our tribe from others, but to explain to ourselves how our ancestors came to live in a particular place in a particular way. But such stories are not fixed. They are edited over time by new ideas that first appear as marginal social practices and only later become codified as explanations for those practices. (Moore, n.d., in press)

Gamestorming in the Logim@s© approach implies weaving together ideas, behaviors, actors, modes of communication and attitudes toward time (Table 5.2).

> So, one way to understand the emergence of sustainability is not as a historically unique situation brought about by a singular case of over-consumption, but as *a periodic and necessary rewriting of the foundation narrative of Western society*. Our current era, as have others before it, requires a *new storyline if we expect history to unfold in a trajectory we can accept on behalf of future generations and those who are now unable to speak for themselves*. (Moore, n.d., in press)

Table 5.2 Storyline Components and Evolution, from Moore (2007)

	premodern		modern			postmodern
storylines	**Heroic**	**Religious**	**Scientific**	**C.I.A.M.**	**Economic**	**Sustainable**
ideals	excellence	goodness	truth	functionalism	growth (quantitative)	development (qualitative)
behaviors	competition	obedience	experimentation	design	maximize	optimize
actors	heroes	saints and prophets	scientists and philosophers	architects and planners	consumers and business	citizens
modes of communication	legends	scripture and prayer	logic	drawings, models and manifestoes	images and numbers	feedback loops
attitude toward time	immortality	eternity	timelessness	*zeitgeist*	now	perpetual renewal

This is the 'spirit' of the UML Case 2: Check for a local storyline, find information sources, studies and specialists to build the storyline and let future players redefine this storyline.

5.4.2.1 Use Case 2 Description

Use Case 2: Find or build a first local storyline

Actors:

- Google Search, Google Scholar, online news and newspapers, online books and magazines
- GD (gamestorming designer)
- DE (domain expert)
- CM (community member)

Goals:

1. Find a local storyline
2. Build a local storyline

Trigger: Logim@s© ecards are completed

Type: Essential

Events Flow:

Table 5.3 UML Case 2: Events Flow

Actors' Actions	System's Answers
1. The GD starts a new session on Resolute case 01 and asks for storyline menu.	2. The system is ready and asks for keywords to locate storyline components.
3. The GD enters keywords.	4. The system sends back a list of relevant links and documents with a storyline template.
5. The GD starts to complete local storyline using one template with a color style by actor category; The GD defines the DE and the CM for the case.	6. The system sends the completed storyline to the DE and CM.
7. Each DE/CM accepts (or not) the task and edits the proposed template.	8. The system contacts experts for synchrone session for final editing of the collaborative storyline.
9. The GD and available DE discuss and edit the storyline.	10. The system publishes the agreed-on version.
11. The GD closes the session.	

Alternative flows:

The GD chooses to cancel the storyline session

The GD looks for a new DE

5.4.3 UML Case 3: Elicit Case Knowledge Using FAC (Flourishing – Artificiality – Cognition) Grid

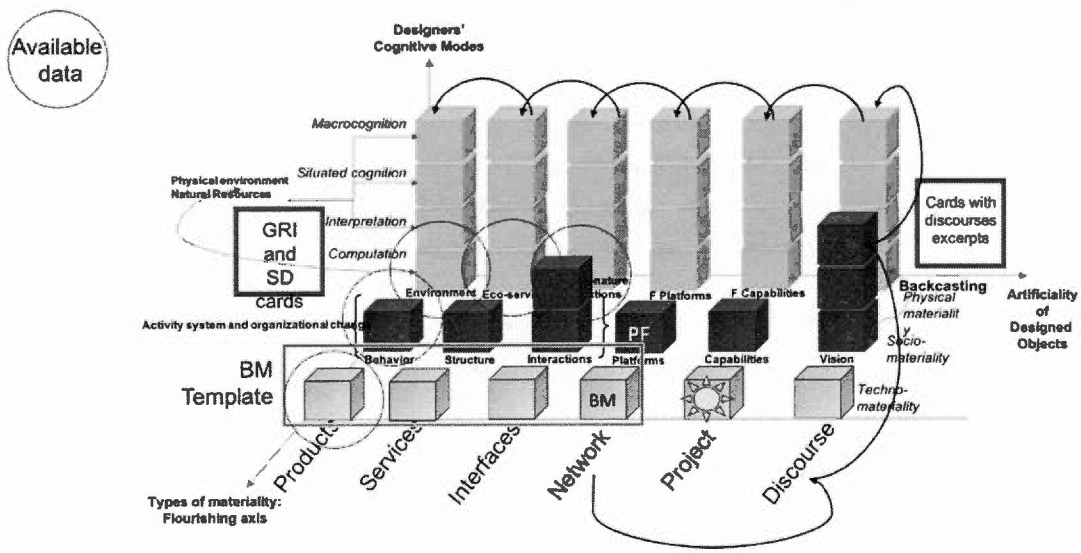


Figure 5.7 Resolute Co. Case Mapped on an FAC Grid

Chapter three proposed a debriefing framework to map players' logical moves with a card. The objective of UML case 3 is to map the new case data (the Resolute Co. described in UML case 1) and to experiment with some abductive reasoning. In practical terms, the designer needs to know in what way what he will offering to gamestormers will work. Therefore, the first step is to locate available data onto the FAC (Flourishing – Artificiality – Cognition framework) like in Figure 5.7.

In Figure 5.7, dotted-line circles point to available data. The Resolute Co. mini-case presents data about natural resources (forest and caribou), eco-services (quantity of wood to be harvested), human–nature interactions (especially with people of the First Nations), company behavior and the Forest Stewardship Council (FSC). The FSC reporting in this case serves as a complement to the GRI reporting. A quick analysis of the Resolute Co. Annual Report (for 2013 only) provides more information. An 'Advanced Search' with Acrobat Professional using keywords from the FAC framework brings up the following information from the 2013 Annual Report:

- On the techno-materiality axis: 172 references to the word 'product' and a few to the words 'service' and 'project'; there are no references to 'model,' 'interface' or 'discourse';
- On the socio-materiality axis: There are a few references to 'vision,' but no references to 'capability' and three references to a media platform;
- On the physical materiality axis: There are many references to 'sustainability' and 'GRI'; there are no references to 'flourishing' or 'strong sustainability.' The Resolute Co. conforms to definitions of GRI materiality.

Moore's twelve 'abductive' sentences about sustainability have already been presented in this thesis. Here again we use these sentences to practice abduction as logical mode. A potential player in the Resolute case, as defined above, will sense the incompatibility of expressed statements (Resolute vs. Greenpeace). Local players will know local storylines as well as have their own view of what the ideal way of life was yesterday, what it is today and what it may be tomorrow. In this situation:

> In abductive reasoning, the observer tries to make sense of a situation that does not make sense with her/his current references. She/he builds different possible scenarios in order to reconstruct the story that could have led to the surprising situation. She/he eliminates some scenarios, she/he may look again at the situation to choose between various scenarios. (Gomez & Lorino, 2005: p. 662)

GDs and players can use each of the following sentences to try to make sense of a situation that doesn't make sense (Table 4.4).

Table 5.4 Twelve 'Abductive' Sentences by Moore (2007) on the Physical Materiality Axis

Natural Elements, Cycles, Resources - (Abduction—Moore) Natural resources do have finite limits, but these can be stretched by human mental labour. - (Abduction—Moore) It is not particularly helpful for citizens to be concerned with scientific 'Truth,' but it is very helpful to figure out what it is that we can do together to solve common problems.
Eco Infrastructure Services - (Abduction—Moore) Conceptual models and lists of best practices are of some heuristic value but tend to divert attention away from local opportunities for action that derive from local storylines already related to sustainable development.
Human–Nature Interactions - (Abduction—Moore) Because humans, nature, and technologies coevolve, changes in one of these variables can never be studied in isolation.
Business Platform Model for Flourishing - (Abduction—Moore) The appearance of new technological codes reflects change social values and stimulate changed social habits. - (Abduction—Moore) Be concerned by the consequences of actions more than their qualities—how brave, simple, or generous they are.
Flourishing Capabilities, Knowledge Use (Abduction—Moore) Projects are likely to be considered successful by more people when experts depend on citizens to define them. (Abduction—Moore) Efficient design will optimize what is technically possible, but effective design will optimize what is socially desirable. (Abduction—Moore) 'Wicked' problems can be solved by employing experimental design thinking, not by sticking with the same scientific assumptions, traditional values, and social habits that created them. (Abduction—Moore) Methods of implementation are theories of conceptualization in disguise.
Backcasting–Effectuation - (Abduction—Moore) Although irrational mobs and disciplined clients can both contribute to sustainable conditions in the short run, rational deliberation among citizens contributes most to the long run. - (Abduction—Moore) Regimes of sustainability will tend to show up in culturally diverse spaces where coalitions of environmentalists and social justice advocates redescribe dominant story lines in ways that are attractive to most citizens.

It is the responsibility of the gamestorming designer to go through this exercise and experiment the richness of the scenarios. Taking the following sentence, 'Projects are likely to be considered successful by more people when experts depend on citizens to define them,' how can we connect the dots? It is not particularly helpful for citizens to be concerned with scientific 'Truth,' but it is very helpful to figure out what it is that they can do together to solve common problems. Resolute's use of GRI categories is about facts and 'truth.' How is it possible to redesign a traditional storyline in which, in a classic scenario, a company comes to exploit local resources as much as it can and then moves elsewhere? At this stage, the gamestorming designer must make sure that adequate knowledge and data will be available for future players. By abduction, using his judgment of goodness for sustainability (whether the design is good or bad, see Latour (2008)) the designer is assisted by the system's complete FAC grid elements to ease the players' future reasoning by abduction (Table 5.5).

> /.../ abduction is necessarily accompanied by expansion or revision of knowledge. In the domain such as design in which rich knowledge is available, a feasible expansion of knowledge is obtained by integrating existing knowledge. Integration of knowledge here does not mean a simple addition of knowledge, but rather such operations as translation and modification. There seem to exist a number of possible ways to integrate knowledge. Abduction as a method to integrate knowledge can satisfy the two aspects of creative design, i.e., creating a new product and expanding knowledge. (Takeda *et al.*, 2003: p. 2)

Yoshikawa (2009) illustrates the (rule => result => case) process in design by the following example:

- Knowledge—Relation between family structures and comfortable houses
- Requirement—A family lives in a comfortable house
- Design—A house comfortable for the family

By the same token a designer assisted by massive online databases can identify knowledge for the rule 'relation between local population and physical environment' and identify the requirement as 'local population lives in flourishing environment' and from there design a flourishing environment for the local population. As mentioned by several prominent researchers, flourishing physical environment design hides a paradox: that sustainability science means integrating knowledge on an abstract level…an integration such as it existed in the past when indigenous people knew what to do in the presence of one fact or another. The sensorimotor system extends to the environment mental categories and its referents. To paraphrase Harnad (Notes), knowing a category means knowing what to do with this category (e.g., edible mushroom -> eat it!). A century and more of separate knowledge at an abstract level or 'scientific knowledge' (Yoshikawa, 2009) has reduced our capacity to mobilize and use relevant knowledge with integration. Therefore, it is quite easy to accumulate scientific knowledge about sustainability and the environment, but it is hard to select and *use* relevant knowledge to design a flourishing environment.

If we look back on 'Resolute Co. Case Mapped on an FAC Grid' (Figure 5.7), we see that the designer should locate available data, look for missing data, update discourse card information, update support card information and understand what the challenge(s) for future players will be. During gamestorming players will defend their own preferences and choices, but the designer will take a backcasting position: he tries not to predict but to design a flourishing future for a given population. The designer is reasoning as follows:

- Knowledge—Economic, social, environmental sciences etc. (fragmented scientific knowledge) document relation between quality of life and flourishing sustainability
- Requirement—A local population deserves flourishing conditions
- Design—A flourishing future for local population

Table 5.5 Differences Between Deduction, Induction and Abduction

Deduction	**Induction**	**Abduction**
Analytical inference	Synthetic inference	Ampliative inference
A priori reasoning: infers an effect from its cause	A posteriori reasoning: infers a cause from its effect	A posteriori reasoning: infers a mutual connection between several effects of one cause
Rule ⇒ Case ⇒ Result	Case ⇒ Result ⇒ Rule	Rule ⇒ Result ⇒ Case
Rule – All the beans from this bag are white Case – These beans are from the bag Result – These beans are white	Case – These beans are from this bag Result – These beans are white Rule – All the beans from this bag are white	Rule – All the beans from this bag are white Result – These beans are white Case – These beans are from this bag
Explains the consequences of a theory	Tests a hypothesis	Generates new knowledge by creating hypothesis
Predicts	Generalizes from a sample to the population	Explains

Source : (Gomez & Lorino, 2005: p. 660)

5.4.3.1 Use Case 3 Description

Use Case 3: Elicit case knowledge using an FAC (Flourishing – Artificiality – Cognition) grid

Actors:

Systems:

Online news, online scientific knowledge, online business references etc.

Search tools

Humans:

GD (gamestorming designer)

DE (domain expert) or specialist

CM (community member) or local person

Goals:

Position given data onto an FAC grid

Look for missing data

Update discourse card information, update support card information

Examine abductive sentences

Examine backcasting reasoning

Trigger: Storyline is completed and validated

Table 5.6 UML Case 3: Events Flow

Actors' Actions	System's Answers
1. The GD starts a new session on Resolute case 01 and asks for the FAC grid menu.	2. The system is ready and displays the FAC grid onscreen as well as the instructions menu.
3. The GD clicks on relevant labels, enters text and types 'return.'	4. The system displays the FAC grid onscreen with a dotted circle around the completed label.
5. The GD clicks relevant labels, enters text and types 'return.'	6. The system displays the FAC onscreen grid a dotted circle around the completed label.
7. The GD asks for a search on empty labels.	8. The system returns links, pdf files, word cloud.
9. The GD is ready to key in more information.	10. The system displays the FAC grid onscreen.
11. The GD clicks on relevant labels, enters text and types 'return.'	12. The system displays the FAC grid onscreen with a dotted circle around the completed label.

13. The GD ends editing label.	14. The system displays a menu.
15. The GD asks to edit ecards.	16. The system displays discourses cards and support cards one by one.
17. The GD edits (or not) a card and asks for the following one.	18. The system provides the next card until end of series.
19. The GD asks for a list of 12 abductive sentences.	20. The system displays sentences one by one.
21. The GD tries reasoning by abduction from each of these 12 sentences and checks if the sentence fits the case well.	22. The system registers the checked sentence for the game in preparation.
23. The GD ends testing sentences and asks for the backcasting menu.	24. The system displays the backcasting menu.
25. The GD chooses backcasting on the flourishing axis.	26. The system displays the flourishing capabilities label.
27. The GD keys in personal notes.	28. The system displays the next label up to natural resources.
29. The GD ends with personal notes and asks for other axis.	30. The system displays other labels one by one.
31. The GD keys in personal notes and closes the session.	

5.4.4 UML Case 4: Build a Gamestorming Experiment (GE)

Our goal is to design a game space in accordance with the definition of Gray et al. (2010: p. 1): "*To enter into a game is to enter another kind of space where the rules of ordinary life are temporarily suspended and replaced by the rules of the game.*" Sitting at a table, a player can spontaneously assume a new role induced by the game or stay bound to a professional role in the city administration and experience frustration. We assume that the players entering the space of the game are ready to adapt to an unknown situation and to take some risks when their beliefs are threatened. But creating this new space implies an appreciation of the distance between that space and the everyday workspace. An open and mobile gamestorming environment can be designed to let players interfere with their usual physical environment in a situated cognition approach. Players working in the forest or at the mill with the Resolute Co. can exchange with people of the First Nations whether in their village or in the forest etc. At a distance, gamestorming can be synchronous using communication software over computers, tablets and iPhones.

Gamestorming architecture should follow the principles defined by Gray et al. (2010):

- Game space: Different actors agree to enter the gamestorming experiment and to conform to the rules of the game. Actors can be the real people involved in some controversies or players acting as real people. Macrocognition principles require that no visible or invisible hierarchy melds or transforms player interaction. The game space is structured by a project to be realized in difficult sustainability conditions. It is up to the GD to invent or adapt a conflict generating project. Checking for macrocognition conditions will be done in another use case.
- Boundaries in time and space: There should be a proposition from the GD to be discussed with future players. Situated cognition principles ask for a distributed game where people continue to live in their usual (natural or artificial) environment.
- Rules for interaction: When to talk, ask questions, debrief, exchange cards, etc.
- Artefacts: Ecards and BMC template
- Goal: When does the game end? When the fixed time has lapsed, or when the last player has justified their BM and sustainability strategy.

5.4.4.1 UML Case 4 Description. Build a Gamestorming Experiment (GE)

System Actors

Webex or Google HangOut

Human Actors

GD (gamestorming designer)

PL (player)

Goals

1. Define a project
2. Define future players
3. Set boundaries in time and space
4. Set interaction rules
5. Set artefacts for period of game
6. Set gamestorming goal

Trigger

Decision to plan a GE (gamestorming experiment)

Table 5.7 UML Case 4: Events Flow

Actors' Actions	System's Answers
1. The GD opens an architecture session for the Resolute Co. case.	2. The system displays a menu.
3. The GD chooses 'Define a project.'	4. The system displays a project template.
5. The GD completes the template's components: project title, project nature, scope, impacted populations, sustainability issues; the GD stops	6. The system displays a menu.

editing.	
7. The GD chooses 'Future Players.'	8. The system displays a player's template with name, address, email, and phone number.
9. The GD keys in requested items; the GD ends editing.	10. The system sends a predefined email to potential players and displays a menu
11. The GD chooses 'Set Boundaries in Time.'	12. The system displays a drop-down calendar.
13. The GD defines a date, a duration, a synchronous mode and ends.	14. The system displays a menu.
15. The GD chooses 'Set Boundaries in Space.'	15. The system displays a Google map.
16. The GD keys in different locations using postal addresses or clicks on map.	17. The system stores locations and displays a menu.
18. The GD chooses 'Interaction Rules.'	19. The system displays extant Logim@s© rules.
20. The GD accepts extant interaction rules.	21. The system stores updated interaction rules and displays a menu.
22. The GD chooses 'Set Artefacts for Period.'	23. The system displays a menu with several options: 1. Review storyline, 2. View and edit ecards and 3. View and edit BMC.
24. The GD reviews and edits three artefacts and asks for the menu.	25. The system displays a menu.
26. The GD chooses 'Set Gamestorming Goal.'	27. The system displays a template.
28. The GD edits the goal and closes the session.	

5.4.5 UML Case 5. Monitor a Gamestorming Experiment (GE)

To make a distance gamestorming possible, some actions must be taken by players, the game designer and the system.

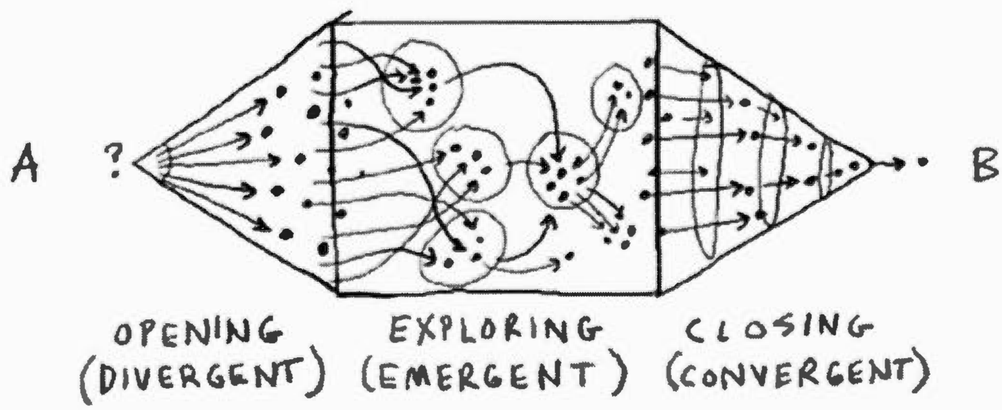


Figure 5.8 Three Periods in Gamestorming

4.4.5.1 UML Case 5 Description. Monitor a Gamestorming Experiment (GE)

System Actors

Google Hangout

Human Actors

GD (gamestorming designer)

PL (player)

Goals

Manage opening period

Manage exploring period

Manage closing period

Trigger

Decision to start a GE (gamestorming experiment)

Table 5.8 UML Case 5: Events Flow

Actors' Actions	System's Answers
1. The GD opens an monitoring session for the Resolute Co. case.	2. The system distributes 'Summary of Interaction Rules and Artefacts' to the PL and displays a menu to GD.
3. The GD selects 'Track Artefacts/Player.'	4. The system distributes discourse ecards at random, displays the 'Discourse card exchanges' menu to the PL and monitors cards owned by the PL.
5. The PL starts to exchange ecards to collect cards of the same colour.	6. The system starts to track card exchanges over time and displays the menu for the GD.
7. The GD confirms the end of the opening period.	8. The system alerts the PL with the message 'Exploring Period for X minutes,' distributes support cards at random and displays the 'Support card exchange' menu to the PL.
9. The PL tries to locate relevant support cards in the hands of other PLs by selecting 'Show player X cards.'	10. The system displays PL X's cards to PL Y and gives access to Hangout profile.
11. PLs X and Y discuss an exchange of cards and make a decision.	12. The system updates the cards owned by the PL and, after the exploring period duration, displays 'Closing Period for Y minutes.'

13. The GD confirms the end of the exploration period.	14. The system closes card exchange activities and starts the Hangout meeting for the GD and all the PLs.
15. The GD confirms the end of the debriefing period.	The system stops the hangout meeting.

5.5 Conclusion

Marsh (2011) insists on the serious experiential and cultural purpose of games: "(The) final range in the continuum encapsulates environments and digital media with minimal to no traditional gaming characteristics whose purpose is to provide potentials or opportunities for experience and emotion through encounters to provide meaning". (Marsh,2011: p. 67)

In that vein, this chapter presented the basic services to be offered by SustAbd© core:

- Evaluate gaming potential of a place-based event/period with incompatible sustainability discourses
- Find or Build a First Local Storyline
- Elicit Case Knowledge Using FAC (Flourishing – Artificiality – Cognition) Grid
- Built a Gamestorming Experiment (GE)
- Monitor a Gamestorming Experiment (GE)

After this, chapter 6 makes a connection with the importance of a need for support in such a transformation process from a huge variety of resources to grafted intelligent tutors:

For Woolf (2009), the education industry is probably at an inflection point that will fundamentally transform how things are done in classrooms, buildings and the physical campuses of educational institutions. Web-based training offers a huge variety of resources that can function as grafted intelligent tutors. The new entity will be a cyberinfrastructure, an educational space, centered on the supply of services. To allow computers to 'think' in this educational space, semantics understandable by computers have been developed to enable the required services, languages, tools, and applications. Training resources will be amended to allow data and intelligent agents to connect the terms of one resource to another, while reasoning about the task of the user. In other words, intelligent software agents will take precedence over human users interacting in their place with data sources and heterogeneous information (Nkambou et al., 2005).

CHAPTER VI

SUSTABDPLAY© VIRTUAL TUTOR SYSTEM DESIGN

6.1 Introduction

The first chapters of this thesis illustrated how BMs and BMFs are cognitive artefacts. In their nature as designed objects (and some designs are better than others), they serve as objects playing a cognitive role (and as objects whose design must support this feature), as external objects with which we interact (from the perspective of situated cognition) and as public objects that several people can use at the same time (and as part of the macrocognitive perspective). The concept of BMs and BMFs as cognitive artefacts could anchor everything we have to say about BMFs on the cognitive level.

Like BM and BMF design, from the data to the discourse universe, conceptual modeling in information systems engineering also follows an artificiality trajectory (Krogstie, Opdahl, & Brinkkemper, 2007). Referring to the FAC grid, these conceptual modeling approaches climb along the cognition axis thanks to goal analysis and ontology-driven development as more interpretative approaches (Bubenko Jr, 2007; Morales et al., 2015; Overbeek et al., 2015). But goal analysis cannot be the ultimate modeling approach: macrocognition and situated cognition must be implemented in a virtual tutor for SustAbd© players.

Usually an intelligent tutor has three parts (in addition to the tutor's interface): the content model, the student model, and the tutor model (Nkambou, Mizoguchi, & Bourdeau, 2010). But the SustAbdPLAY© tutor has not been developed for a well-structured knowledge domain. Conversely the tutor will serve under ambiguous situations where goals are fuzzy and knowledge domains around BMs and BMFs are ill defined (Land, 2000).

In fact, we want tutor-assisted players to be challenged with:

- Use of different knowledge types on each FAC grid point intersecting the main axis with a transverse axis (e.g., 'products—behaviours—natural resources' or 'discourse—vision—backcasting')
- Moves on the FAC grid experiencing different routes toward more concrete materiality levels (from techno- socio to physical materiality)
- Cognitive processes that change toward higher cognition levels: from individual computation to interpretation, situated cognition and macrocognition
- More agility (speed, precision) when navigating or dialoguing back and forth along the artificiality trajectory on different main axes (BMs or BMFs are not an isolated bounded cognitive artifact but a model between concrete data and abstract theory or discourse, vision, backcasting).
- Abduction as logical mode to be developed by players trying the backcasting approach.

Building on this researcher's experience as a human tutor in inverted teaching and gamestorming experiments, the intent in this chapter is to adopt cognitive modeling (CM) as an approach devised to replace a human tutor with an embedded robot (Figure 6.1).

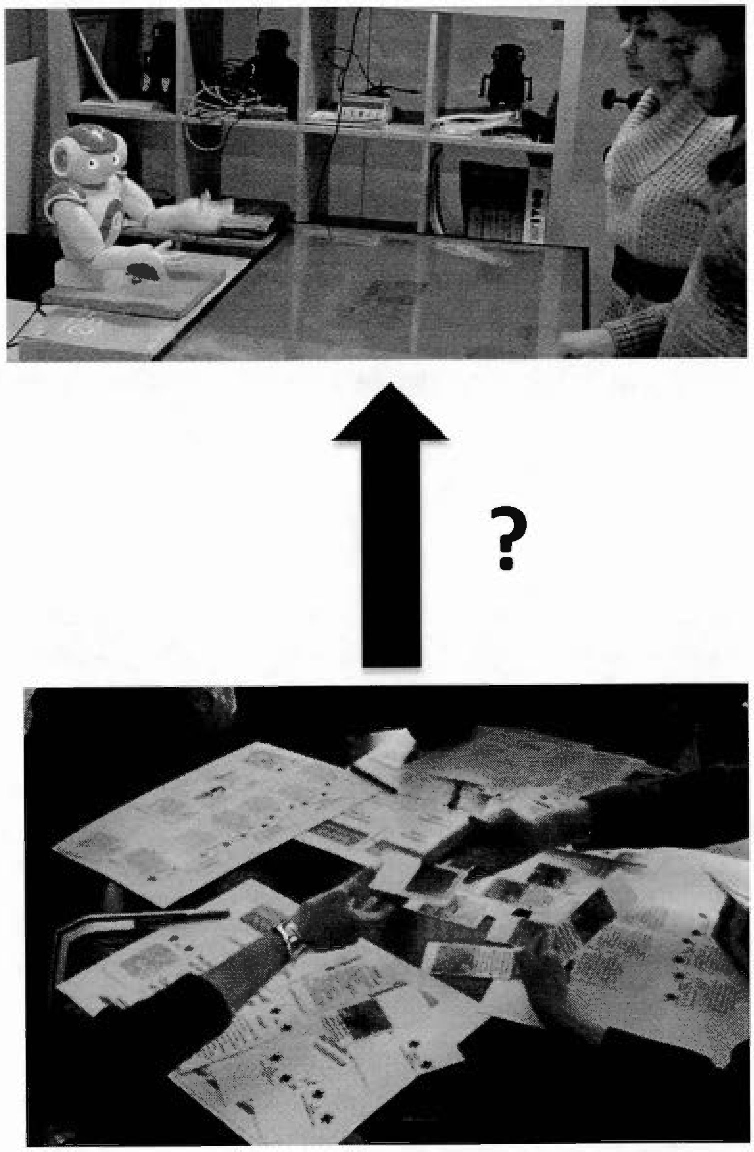


Figure 6.1 From Human Tutor to Embedded Robot as Tutor

Ribeiro et al. (2014) designed a robot-tutor for the serious Enercities-2 game illustrated in Figure 6.1. This robot is an embodied 'toy' (Harnad, 2003) acting as a peer student and collaborating in the game with two other students. The interactive Enercities-2 demo uses a large tablet surrounded by the embodied robot and the two students. If the game were about a flourishing BM, what kind of robot would be derived from cognitive science paradigms? Osterwalder and Pigneur (2010), in association with BM Foundry, conceived an Apple app to map data unto their BM canvas and compute costs and revenues. The software provides help and a visual interface. Its visual interface can be used in a robot-tutor type game by being projected on the large interactive tablet. But SustAbdPLAY© as a BMF gamestorming tutor is not supported by the traditional BMC approach. However, the literature on business games and 'education for sustainability' (ESD) could be helpful to face sustainability challenges.

> In terms of pedagogy, we find that business games provide an effective alternative to traditional teaching methods. This method exposes students to facets of organizations that other methods simply cannot. For example, students, as members of top management teams, create their own organizational culture. (Ben-Zvi & Carton, 2008: p. 270)

And learning games make it possible *to link abstracts concepts and real-world problems*, which brings the situated cognition approach in sustainability to the forefront:

> 'If we learn something from each game that we play, we have accomplished something; and we just need to implement that into our everyday play.' Joyce Bickers' words are relevant to the ensuing discussion on games and their merits. From an educational perspective, games are important motivational and learning tools (Garris *et al.*, 2002), a link between abstracts concepts and real-world problems /…/. (Ben-Zvi & Carton, 2008, p. 265)

To cultivate intimate knowledge of one's home ground, these authors propose 'En Plein Air,' a mobile learning environment. Following this option, SustAbdPLAY©

could be described as a real-time tutor for people at a distance connected to SustAbd© through mobile devices.

The taxonomy of Anderson et al. (2001: p. 29) will help us examine the FAC grid more deeply to identify SustAbdPLAY© requirements. But what is suitable for BMC tutoring isn't the right fit for BMF tutoring according to specialists in sustainability education:

> In a recent paper, published in the Journal of Sustainability Education, Burgess & Johannessen (2010) challenge the current ESD practices in many respects. By reviewing several studies, the authors highlight a trend: "we have watched sustainability education grow and define itself in contrast to place-based, nature-centered, experiential environmental education and see this as a detriment to the emerging discipline's ability to accomplish its stated goals." According to their perspective, ESD has been more focused on abstract and theoretical learning on economic and social issues, without building an underlying curricular foundation based around experiencing the natural world. They believe that to pursue ecosystem-based resource management, to understand functional ecosystem processes, or to gain an systemic understanding of sustainability requires '*the cultivation of intimate knowledge of one's home ground, of paying close attention to one's surroundings and exploring one's values and feelings based on the relationship of people to nature.*' (Giusti *et al.*, 2012) (Emphasis added)

After briefly taking stock of the respective challenges and goals and robots' or the meaning of agents' 'intelligence' in serious games vs. mobile learning, this chapter continues with thoughts about situated robots borrowed from Clancey's (1997) work. These ideas make it possible to devise SustAbdPLAY© in accordance with situatedness and macrocognition by distinguishing between individuals devising a new course of actions inside a community compliant with macrocognition conditions and individuals acting under instructions from others inside a hierarchy. Then, new

UML use cases should be derived like getting to know each other and establishing a players' community. Instead, we make the proposal to apply iStar (i*) as an approach to elicit players' intentional and social dimensions. The chapter ends with a few concluding statements.

6.2 Serious Games vs. Mobile Learning: Smart Challenges

'Intelligence' levels (Davenport and Kirby, 2016) should be interpreted here in the context of a 'place-based' social and mobile learning environment that targets ecosystem-based resource management and is designed to understand functional ecosystem processes and gain an systemic understanding of sustainability (Giusti et al., 2012), while enabling social interactions about BMF design that are mediated and structured by a game inspired by LogiM@s©.

Table 6.1 Levels of Intelligence and Task Type

LEVELS OF INTELLIGENCE

TASK TYPE	SUPPORT FOR HUMANS	REPETITIVE TASK AUTOMATION	CONTEXT AWARENESS AND LEARNING	SELF-AWARENESS
Analyze Numbers	Business intelligence, data visualization, hypothesis-driven analytics	Operational analytics, scoring, model management	Machine learning, neural networks	Not yet
Analyze Words and Images	Character and speech recognition	Image recognition, machine vision	IBM Watson, natural language processing	Not yet
Perform Digital Tasks	Business process management	Rules engines, robotic process automation	Not yet	Not yet
Perform Physical Tasks	Remote operation of equipment	Industrial robotics, collaborative robotics	Autonomous robots, vehicles	Not yet

THE GREAT CONVERGENCE

Source: Davenport and Kirby (2016)

Let's take as an example the North Dakota pipeline protest. As we can read on the CBC website:

> Tribal flags, horses, tents, hand-built shelters and teepees dominate one of the biggest, newest communities in North Dakota, built in a valley on federal land near the confluence of the Missouri and Cannonball rivers. It's a semi-permanent, sprawling gathering with a new school for dozens of children and an increasingly organized system to deliver water and meals to the hundreds, sometimes thousands, of people from tribes across North America who've joined the Standing Rock Sioux in their legal fight against the Dakota Access oil pipeline to protect sacred sites and a river that's a source of water for millions of people.[48]

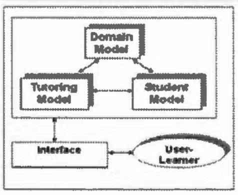
Referring to this place and its ecosystems, data should be collected and analyzed from different databases with some social and ecological context awareness. A smart drone could also observe different places looking for impacts and record images of damage caused to an ecosystem. If opposing stakeholders in such a situation experimented with SustAbd©, then their conversations in the gaming context should be guided, analyzed and 'understood' by an intelligent tutor called SustAbdPLAY©. In Table 6.1, a context awareness and learning intelligence level should be reached.

It is our understanding that mobile learning requires more context awareness and thus a higher level of intelligence to analyze numbers, words and images and perform physical tasks like operating autonomous robots, vehicles and drones to explore a specific place. Awareness as a topic is on many researchers' agenda, from 'cultural awareness' (Blanchard & Ogan, 2010) applied to tutor design (Bourdeau & Grandbastien, 2010) to 'environmental awareness' (Lin et al., 2008) associated with mobile game development. Figure 6.2 illustrates a progression from a computer-based limited knowledge domain (a tutorial system) to an open knowledge domain

[48] http://www.cbc.ca/news/indigenous/north-dakota-pipeline-protest-1.3766637 (Visited in 2016 on November, 12)

and online situated game used by gamers exploring their 'place' (mobile learning). Between these domains are the serious game approach, which is abstract and virtual, and the gamestorming approach.

Intelligent Tutorial System	Serious Game	Gamestorming	Mobile Learning: Open and on-line situated game
Sustainability Science	Deloitte Sustainability Game	SSBMG Toronto	'En plein air'
Notion of task vs. Flourishing experiment?	Complex and expensive development	Can be simple, analogy with 'brainstorming'	Technological complexity to implement situated and macrocognition
Limited domain with explicit knowledge	Vitual world vs. Real world Gamification vs. Flourishing?	Abstraction from the real world	In use when experimenting the world



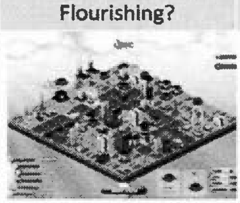


Figure 6.2: Four Gaming Concepts to Implement SustAbd©

What would the concept of a tutorial system become in an open, online, multi-player mobile learning experiment? Basically, a tutorial system would be better dedicated to sustainability science used to learn, diagnose and solve sustainability problems. In a mobile learning environment, the tutor becomes a game facilitator, explaining the rules and the artefacts' roles, while bringing in more data and information at the request of the players. Adapting the Tchounikine (2009: p. 12) representation of the computer-aided part of a tutorial system, Figure 6.3 distinguishes the table game presented in chapter three (an activity performed without computer assistance) from a computer-aided mobile learning environment featuring the future tutor and game facilitator. Various trans-disciplinary contributions to game design (Arnab & Clarke, 2016) applied to land (Bishop, 2011; Cowley et al., 2011) and community (Andrade

& de Carvalho, 2013; Giannetto et al., 2013) could help in describing this tutor. Also, more encompassing design prescriptions and theories around gaming and game design may be of help (Deterding et al., 2011 & 2013; Khaled et al., 2013; Larsen, 2012; Rosario & Widmeyer, 2009 and Starks, 2014).

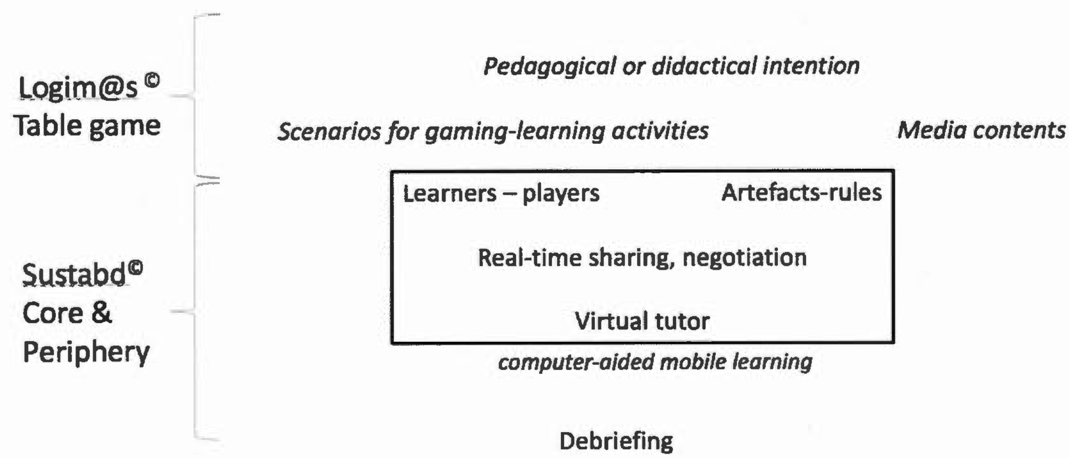


Figure 6.3: Computer-Aided Mobile Learning in the LogiM@s©/Sustabd© Case

6.3 Situated System Design Through Cognitive Modeling

To illustrate AI (artificial intelligence) vs. CM (cognitive modeling) approaches, Harnad (2004) wrote that in AI you ask a cognitive scientist to make a robot dedicated to this or that competence or capability, but in CM you ask a cognitive scientist to make a robot that will emulate an existing cognitive system to better *understand* it. The intention behind this chapter is not to automate BM innovation, but to better understand, particularly through CM, how F Practices could emerge cognitively from gamestorming players assisted by an intelligent virtual tutor. Tutor specifications should consider that the business world uses the concept of sustainability at varying levels of meaning and that managers experiment with it either with acute consciousness or absence of awareness of natural environment challenges and associated beliefs. We thus must understand how cognitive science can help to conceptualize new BMF design by referring to Turing. In his seminal paper (1950), Turing introduced the *indistinguishability* test between a computer and a man to define intelligence with respect to a computer. If a gamer (Turing called his test a 'game') confused a computer for a man, the computer was deemed intelligent.

> Here is the beginning of the difference between the field of artificial intelligence (AI), whose goal is merely to generate a useful performance tool, and cognitive modeling (CM), whose goal is *to explain how human cognition is generated.* A device we built but without knowing how it works would suffice for AI but not for CM. (Harnad, 2004)

Under AI paradigms, SustAbdPLAY© design would be *data driven*, but with cognitive modeling SustAbdPLAY© will be *expectation driven*. In the realm of business analytics and Big Data, AI analysts try to articulate new BMs from data analysis. We acknowledge that this AI approach is adequate for value creation and may be captured inside a continuous dialogue between the theory of the business and data gleaned from the world. But, per Dennett (1998), CM's top-down design implies "interpretive dispositions in the perceiver due to the perceiver's particular knowledge and interests."

In this CM approach to SustAbdPLAY© design, there are dialogues to be invented: First between data and the theory of the business (Drucker, 1994); second, between strategic expectations and organizational architecture and, third, between data about natural resources and backcasting. Taken together, both data-driven and expectation-driven approaches provide ways to conceptualize/design these three dialogues around SustAbdPLAY©.

How should the human tutor think, through the CM approach, about a future embodied robot acting as a substitute for himself to finally devise a disembodied virtual tutor? Clancey (1997) has developed a deep AI view of the evolution of cognition science: from AI to situated cognition and situated robots. To introduce situated cognition, Clancey (1997) starts with Aaron, a robot designed by Harold Cohen to automatically produce original drawings. By analogy, in our mind, Aaron's drawings could serve as BM sketches in a closed-design approach. But, can Aaron contribute to BMF sketches? Aaron[49] is activated by internal mechanisms, that function like a grammar, and by a typology of drawings, anatomical properties etc., much like BM formal ontologies developed by Osterwalder (2004). The observers, and Aaron's designer, began by observing Aaron's behaviour (Note: the observers' stories and their existence are ignored in Osterwalder's BMC approach). "Cohen's design is based on the essential distinction between a mechanism and an observer's perception of patterns in the robot's behavior in some environment over time." (pp. 16-17) But the observers tend to overestimate the mechanism's complexity. We can admit that an Aaron-like robot for BMC is possible, but what about collective BMF design and F Practices generation? There are parallels that can be drawn between the BMC robot and the BMF art, such as the differences Clancey underlines between Aaron and what an artist knows. For Clancey (1997: p. 18), we must distinguish between:

- The storage of pattern descriptions in the robot's memory

[49] See http://www.viewingspace.com/genetics_culture/pages_genetics_culture/gc_w05/cohen_h.htm

- Attributions an observer makes about Aaron drawings
- How people imagine experiences from memory
- Claims about human memory

More than that, Cohen, the designer, must keep in contact with the community of artists because he has many roles which include:

- Interpreting Aaron's drawings
- Selecting and coloring these drawings for exhibits
- Reinterpreting why Aaron's code does what it does
- Reconceiving what he wants Aaron to do
- Participating in the communities of artists and computer scientists

An Aaron-like BMF tutor should be a driver and an enabler of community of practice (CoP) and macrocognition conditions. From this example, Clancey proposes three perspectives on situated cognition (see Table 6.2).

Table 6.2 Three Perspectives About Situated Cognition (Clancey, 1997: p. 23)

Perspective	Interpretation
(Functional form analysis) Social	Organized by interpersonal perception and action: conceptually about social relations (norms, roles, motivations, choreographies, participation frameworks)
(Structural mechanism analysis) Interactive Ready-at-hand	Dynamically coupled state-sensory-effector relations: reactive co-organization Physically coupled, non-objectified connection ("seen through," without description)
(Behavioural content analysis) Grounded	Located in some everyday physical activity, an interactive spatial-temporal setting

Thus, for Clancey: "To build a robot capable of learning and coordinating behavior like a human, we might attempt to better understand the three kinds of situatedness:

1. How perceiving and moving are related (the structural view)?
2. How this physical coordination process is related to conceptualizing activities, whose content is inherently social (functional view)?
3. How subconscious process of perceiving and conceiving relate to the inherently conscious process of representing in speech, text, drawings and so on (the behavioural view)?" (pp.25-26)

Simplifying his framework, Clancey wrote that two ideas about conceptualization can be brought to the fore:

- In people, physical recoordination usually involves conceptualization.
- Conceptual understanding of place, activity, role, and value is socially developed and constituted. (p. 27)

To summarize, cognition is situated, on the one hand, by the way conceptualizing relates to sensorimotor coordination and, on the other hand, by the way conceptualization, in conscious beings, is about the agent's role, place, and values in society. (pp. 27-28).

In situated cognition, there is thus a theory about mechanism (intellectual skills are also perceptual-motor skills) and a theory about content (human activity is, first and foremost, organized by conceptualizing the self as a participant-actor, and this always with respect to communities of practice) (p. 27).

Taken together, these two theories allow people to conceive that they are conceiving.

For the sake of illustration, if we posit that a human tutor must be replaced by a situated robot called SustAbdPLAY©, how will a robot assist the players in a situated way? What are the robot's expected capabilities as determined by our expectations and particular knowledge? Let's suppose there's a gamestorming experiment where nine players are simultaneously examining SustAbd© cards (Figure 6.4).

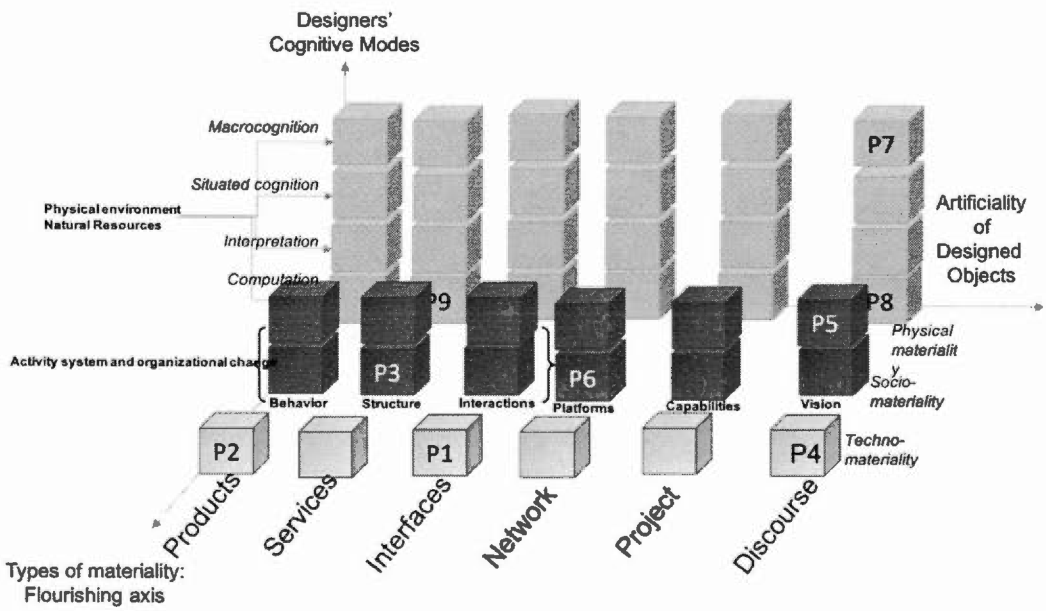


Figure 6.4 Tracking Cards 'At Hand'

A tracking system 'knows' the type of cards players will consider for future exchange. A tracking system (Figure 6.4) produces and gives the FAC coordinates to SustAbdPLAY©. Player 1 (P1) is strictly in the BM area, P2 is located in the products areas and P3, in the activity system; together they explore the traditional BM definition. Player 4 examines discourses from the BM; player 5 examines the vision statement in a situated cognition mode, which might mean that he is checking with relatives for consequences of this vision. Player 7 is backcasting physical materiality in macrocognition mode, which might mean that she is communicating with a member or members of a community involved in some type of ecological change. Only players 5 and 7 are not in a regular computational state.

Player 1 already has assistance and support. He is typically well served by the BMC template (a template in business modeling software like Lucidchart©) and its theoretical and software assistance. In this configuration BMC domain content is rather well defined; BMCs belong to the closed design type, and procedures are explicitly described.

A key question for Clancey is how perceiving and moving are related in what he calls the structural view. In the context of SustAbdPLAY©, situatedness can be seen as changes in a robot's or agent's behaviour when progressing from the left side to the right side of the FAC grid. Per Anderson et al. (2001), it is a progression from factual knowledge to be remembered to meta-knowledge to be used to create something new (Figure 6.5 & Table 6.3).

The recent contribution of Anderson et al. (2001) is to integrate knowledge types into Bloom's taxonomy.[50] To reach their objective, the authors built a matrix between cognitive processes (verbs derived from Bloom's initial taxonomy) and categories of knowledge. Table 6.3 displays the resultant matrix. In this framework or taxonomy (in taxonomy, the categories lie along a continuum), educational objectives are defined at the same time by a verb (a cognitive process) and a noun (a type of knowledge students are expected to acquire or construct) (Anderson et al. 2001; pp. 4-5).

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[50] In 1956, a framework for categorizing educational objectives was published by Bloom et al. under the title *The Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook I: Cognitive Domain*. This original handbook was translated into more than twenty languages. It is the book that had the most influence or resonance on American education during the 20th century (Anderson et al, 2001: Page xxi).

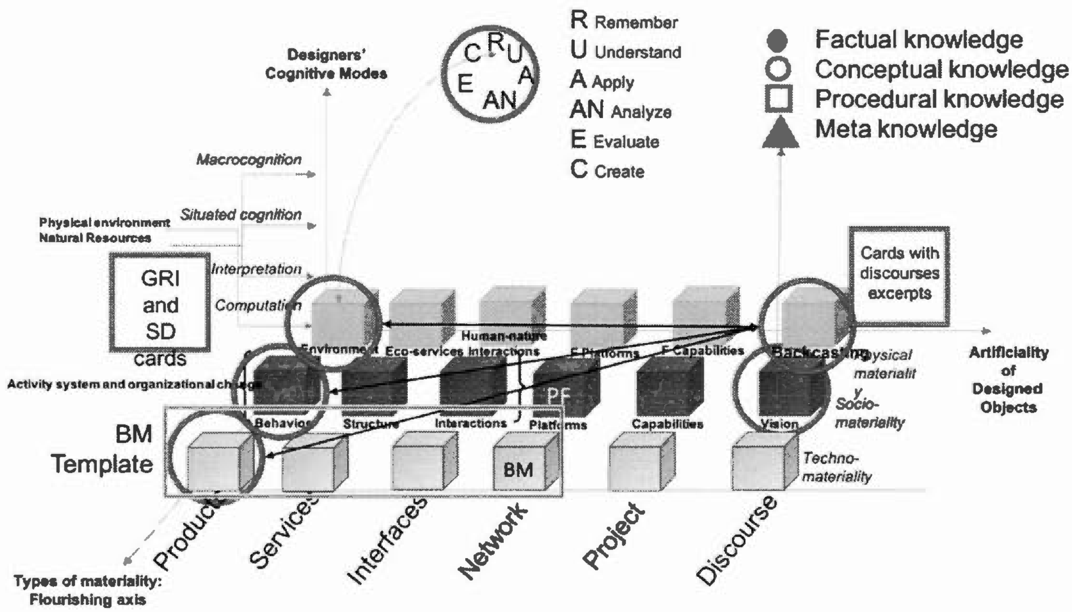

Figure 6.5 An Intelligent Environment for Sustainability

We have to take into account the nature of an ill-defined knowledge domain while using the Anderson et al. (2001) framework. Nkambou, Mizoguchi and Bourdeau (2010: pp. 82-83) quote Lynch et al. and underscore that domains having one or more of the following characteristics are ill defined (Lynch et al. 2006):[51]

(1) "Multiple and controversial solutions: Domains having problems with many controversial solutions and no clear procedures for evaluating a solution are ill defined (…) and particularly ethical problems by definition have no right answer."

(2) "No complete formal domain theory": Sustainability is a functional concept generating multiple debates.

(3) "Ill-defined task structure: (…) in particular, 'design domains' contain tasks involving the design of new artefacts" (e.g., devising a new BM and a new BMF).

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[51] See also Mitrovic & Weerasinghe (2009) and Fournier-Viger, Nkambou & Mephu Nguifo (2010).

(4) "Open-textured concepts: 'Open-textured concepts' are abstract concepts that are partially undetermined or do not have absolute definitions," as is the case with the concepts of business model, flourishing future, sustainability and organizational architecture.

(5) "Overlapping sub-problems: Domains having complex problems that cannot be divided into smaller independent sub-problems that are easier to solve are also said to be ill-defined." Conversely, knowledge use, abduction, effectuation and backcasting are usual cognitive postures for people willing societal and environmental changes.

What *is* a cognitive process according to Anderson et al. (2001)? It is a cognitive capacity that the student should be able to demonstrate (i.e., understand). The authors define the main processes in the following way:

Remember: Retrieve relevant knowledge from long-term memory.

Understand: Construct meaning from instructional messages, including oral, written, and graphic communication (Other verbs: interpret, exemplify, classify, summarize, infer, compare, and explain).

Apply: Carry out or use a procedure in a given situation (Other verbs: execute, implement).

Analyse: Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose (Other verbs: differentiate, organize and attribute).

Evaluate: Make judgments based on criteria and standards (Other verbs: check, critique).

Create: Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure (Other verbs: generate, plan and produce).

Table 6.3 The Taxonomy Table by Anderson et al. (2001)

The Knowledge Dimension	**The Cognitive Process Dimension**					
	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual knowlege						
B. Conceptual knowledge		No complete formal domain theory	Open-textured concepts	Overlapping sub-problems		
C. Procedural knowledge			Ill-defined task structure		No clear procedures for evaluating a solution	
D. Meta-cognitive knowledge						

As in the Anderson et al. (2001) framework, cognitive processes are put in a matrix with various types of knowledge. The knowledge categories are as follows:

Factual knowledge: The basic elements students must know to be acquainted with a discipline or solve a problem (Also: knowledge of terminology, knowledge of specific details and elements).

Conceptual knowledge: The interrelationships between the basic elements within a larger structure that enable them to function together (Also: knowledge of classifications and categories, knowledge of principles and generalizations, knowledge of theories, models and structures).

Procedural knowledge: How to do something, methods of inquiry and criteria for using skills, algorithms, techniques and methods (Also: knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, knowledge of criteria for determining when to use appropriate procedures).

Metacognitive knowledge: Knowledge of cognition in general, as well as awareness and knowledge of one's own cognition (Also: strategic knowledge, knowledge about cognitive tasks, including appropriate contextual and conditional; knowledge, self-knowledge).

Had the work of Gagné[52] (1965) been applied, we could have derived a more elaborate ontology describing knowledge learning issues. Per Gagné, learning is a complex cognitive process implying that every element of knowledge is properly identified, as well as strategies and educational approaches that can facilitate its acquisition by a learner.

As a pioneer of educative psychology (Gagné, 1965; Gagné, Briggs & Wager 1992), Robert Gagné has defined a more refined taxonomy that includes five categories of knowledge ranging from verbal information (principles, proposal, law, etc.) to intellectual skills (concepts, rules, etc.) through attitudes, metacognitive skills and sensorimotor skills.

Table 6.3 shows that ill-defined domain characteristics are conceptual and procedural. Factual knowledge and meta-knowledge have different natures. Facts can be ill defined if the units are wrong, measurement instruments are not reliable and results are not understandable by laymen. For example, an observation like the following one published in *Le Monde*[53] about the Fukushima nuclear plant is not easily understandable in terms of immediate danger and consequences on the physical environment:

> (...) then a corium formed, a magma with a very high temperature (over 2000° C) which is extremely radioactive, and which aggregates uranium, plutonium

[52] http://www.instructionaldesign.org/theories/conditions-learning.html, visited on April 18, 2015

[53] http://bigbrowser.blog.lemonde.fr/2015/04/14/ces-robots-qui-font-le-sale-travail-a-fukushima/, visited on April 14, 2015.

> fission and molten metal from the fuel cladding of zirconium alloy and the internal structures of the reactors. (Our translation)

This observation illustrates the thought of Antal & Hukkinen (2010, p. 941), which states that "in contrast to the myths and stories of ancient peoples, the underlying knowledge and reasoning of contemporary societies is grounded in science." A careful exposition of facts is key but access to science and particularly sustainability science is the essence of factual knowledge acquisition. Meta-knowledge observation resonates with Engeström and Sannino (2012: p. 201): "Functional concepts are loaded with affects, hopes, fears, values, and collective intentions." Meta-knowledge is approximated, according to Anderson et al. (2001), by knowledge of cognition in general as well as awareness and knowledge of one's own cognition.

Conceptual and procedural knowledge about sustainability is ill defined, which is the reason why Ehrenfeld retreated from using sustainability in his discourses and started using the word 'flourishing.' As an illustration, during the Climate Change Summit held in Quebec City (April 14, 2015), Alberta's PM declared that his province was a leader in countering climate change (while its gas emissions are more important than those of Quebec and Ontario put together). Brundtland's sustainable development definition belongs to ill-defined conceptual knowledge and is naturally subject to confrontation and contestation as well as negotiation and blending as a functional concept (Engeström and Sannino, 2012). GRI reporting practices are procedural knowledge based on a functional concept, and hence are difficult to apply and evaluate.

Gamestorming around BMF design to let new F Practices emerge cannot be done by manipulating conceptual and procedural knowledge about sustainability, except in a hierarchical context, because the strategic apex decides what sustainability is and where the solutions (like the carbon market) are, as is already done with different organizational 'greening' strategies. The respect of macrocognition conditions leaves the gamestorming designer with two routes: clarifying the facts (e.g., with sustainability science ontology) and clarifying individual meta-knowledge to see if an individual's goal is really 'Getting There' in Ehrenfeld's words.

SustAbdPLAY© should assist a player in clarifying the facts and proposing something like backcasting—abduction—'getting there.' Since abduction relates to facts, and surprising facts at that (Nubiola, 2005; Gonzalez & Haselager, 2005), this chapter proposes following UML cases (Figure 5.4). But we won't using UML for these last few cases, and we will instead apply intentional modeling with iStar 2.0.

So, five UML use cases were already presented in chapter five:

1. Evaluate gaming potential
2. Build storyline
3. Elicit knowledge with FAC grid
4. Architect gamestorming experiment
5. Monitor gamestorming experiment

This chapter should add those projected use cases:

1. Getting to know each other
2. Establish player's community
3. Establish player's hierarchy
4. Offer backcasting assistance

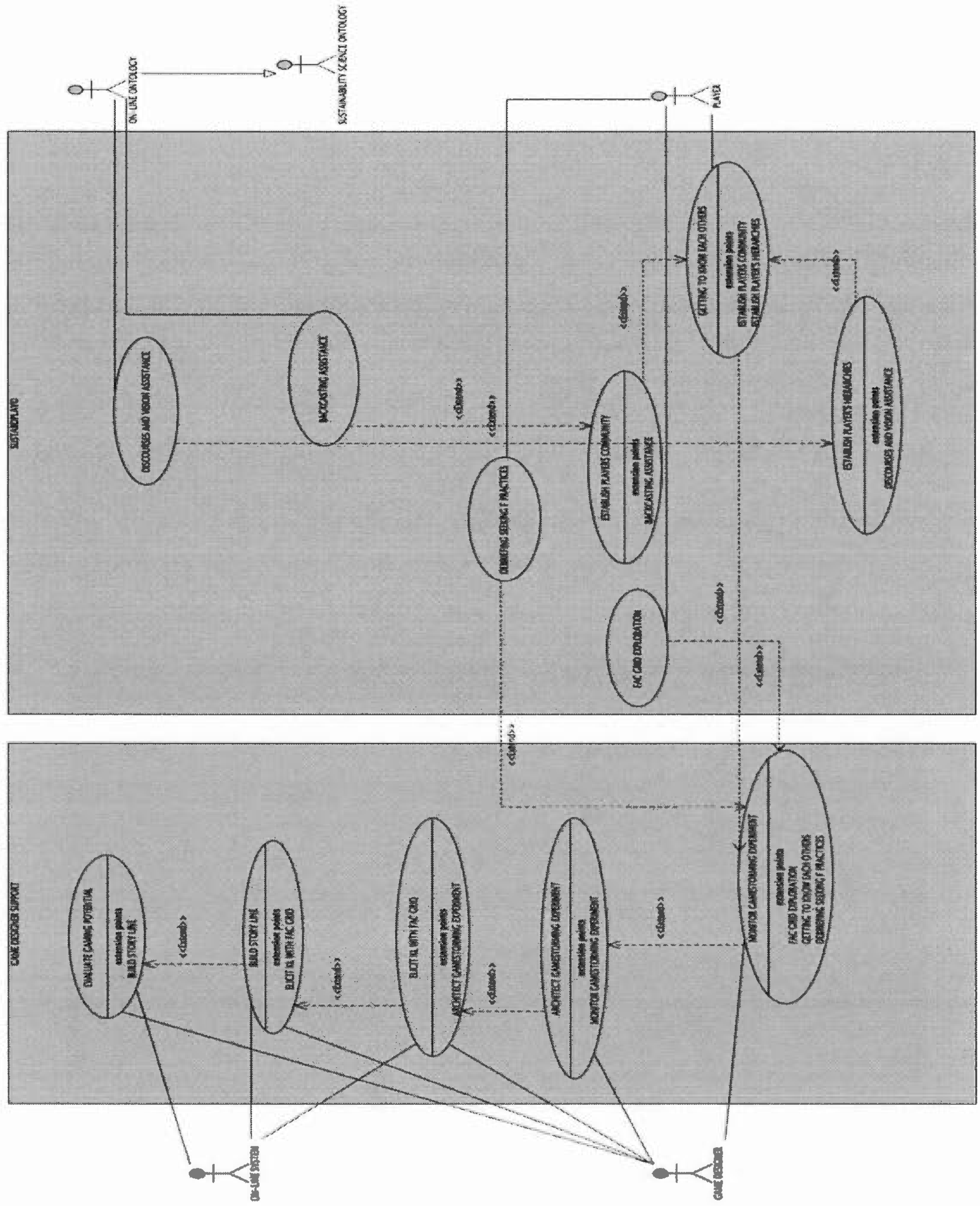

Figure 6.6 UML Use Cases To Build SustAbdPLAY©

The three first 'cases' non-yet documented are essentially both social and intentional. 'Getting to know each other' could be supported by a social media software like Facebook. The same applies for the two other cases: 'Establish player's community' and 'Establish player's hierarchy.' We need more than a frozen actor without goal(s) and beliefs, and recent approaches in socio-technical systems modeling can offer solutions. Why move toward intentional modeling?

> In a keynote speech in 1997, Professor John Mylopoulos identified four main classes of modeling ontologies that would be crucial "in the time of the revolution." Static and dynamic ontologies were well developed and widely adopted. Two new kinds of modeling—intentional and social—were needed to respond to the emerging needs of the information revolution. (Yu, 2009)

We must recognize that the UML 'Use case' approach covers only functional goals, with actors directly involved in operations (typically with software).[54] Dalpiaz et al. (2016) are the authors of the iStar 2.0 guideline, and they define iStar's development motivation:

> The i* modeling language was introduced to fill the gap in the spectrum of conceptual modeling languages, focusing on the intentional (why?), social (who?), and strategic (how? how else?) dimensions. i* has been applied in many areas, e.g., healthcare, security analysis, eCommerce. The i* language was presented in the mid-nineties as a goal- and actor-oriented modeling and reasoning framework. It consists of a modeling language along with reasoning techniques for analyzing created models. i* was quickly adopted by the research community in fields such as requirements engineering and business modeling. (Dalpiaz et al., 2016)

Adding to this guideline, the first iStar 2.0 compliant tool was released by researchers in Brazil (see http://www.cin.ufpe.br/~jhcp/pistar/).

[54] From https://en.wikipedia.org/wiki/I*), visited November19, 2016.

> Intentional elements are the things actors want. As such, they model different kinds of requirements and are central to the iStar 2.0 language. An intentional element appearing inside the boundary of an actor denotes something that is desired or wanted by that actor. An intentional element can also appear outside of actor boundaries, as part of a dependency relationship between two actors. (Dalpiaz et al., 2016)

In this section, we focus on elements inside actor boundaries. The following elements are included in the language iStar 2.0:

Goal: A state of affairs that the actor wants to achieve and that has clear-cut achievement criteria.

Quality: An attribute for which an actor desires some level of achievement. For example, the entity could be the system under development and a quality, its performance; another entity could be the business being analyzed and a quality, the yearly profit. The level of achievement may be defined precisely or kept vague. Qualities can guide the search for ways of achieving goals and also serve as criteria for evaluating alternative ways of achieving goals.

Task: Represents actions that an actor wants to be executed, usually with the purpose of achieving some goal.

Resource: A physical or informational entity that the actor requires in order to perform a task. Goals are graphically represented as ovals, while qualities are represented as more curved cloud-like shapes. Tasks are represented as hexagons to highlight their more structured definition in terms of a process to be followed. Resources are represented as rectangles (Dalpiaz et al., 2016).

Figure 6.7 shows how to do this using iStar 2.0 and the piStar online tool. In using them, it is both easy and relevant to describe and display player profiles. In Figure 6.7, player 21 has the goal of computing business value, while player 11 tries to contribute to ecological value within her community.

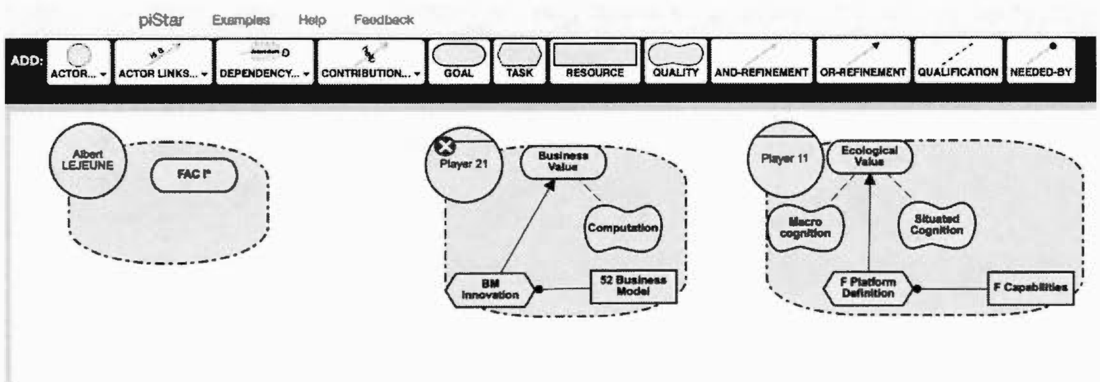

Figure 6.7 iStar 1: Getting to Know Each Other and Connected Communities

Player 21 is concentrating on an BM innovation task, while player 11 tries to define characteristics of an F Platform (Figure 6.7). SustAbdPLAY© doesn't have to access each player's privacy but must provide an opportunity for each player (PL) to introduce himself or herself by declaring some aspects of his or her values/beliefs about facts in physical environment and his/her communities.[55] Players' goals could be inferred from this questionnaire (Table 6.4). A simple questionnaire elaborated from case facts (e.g., Resolute Co.) can be completed by each player.

The questionnaire proposed at Table 6.4 is not about deep statistics but offers a way to link metacognitive and factual knowledge in a coherent configuration. What a PL fears the most will generate his or her priorities. Hoping is a control variable (the PL doesn't hope for what he or she fears), while belief establishes a possible denial of the facts.

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[55] However, declaring some aspects of PL to be values/beliefs cannot avoid infringing on privacy and may cause potential harm to the disclosing person whether the disclosures to the system become known to other actors intentionally or not.

Table 6.4 Example of a Simple Questionnaire

PL name (pseudo)	**Simple Facts**					
	Caribous are dying by the hundreds.	# workers are losing their jobs.	Wood production is increasing by #%.	Native people are losing their territorial rights.	Resolute Co. profits equal $# and are increasing at a rate of #%.	Deforestation has reached a level of #%.
I fear (%)	100	40	100	80	50	100
I hope (%)	0	0	0	0	0	0
I believe (%)	100	100	100	100	100	100
My priority 1 (first) to 6 (last)—is generated from 'I fear'	1	6	2	4	5	3

Per Clancey (1997: p. 27), "[c]onceptual understanding of place, activity, role, and value is socially developed and constituted." A simple question may be to ask each player to help situate his or her conceptualizing ability socially. Players can be members of one or several communities and/or hierarchies. Questions to be asked are: Are you a member of a community or a hierarchy connected with one or more of the simple facts in the questionnaire? Can you name these communities/hierarchies? Simple facts may be disturbing facts that belong to an inconvenient truth for communities/hierarchies. Examples are as follows:

- A Native community relates to Native rights' violations.

- A mayor is a member of a political/administrative hierarchy connected with the loss of jobs etc.

The game must identify each player profile with his/her own meta-knowledge (values, beliefs, hopes, fears concerning physical environment) and identify membership of each player with local communities, communities of practice, communities of wisdom, communities of interests concerning physical environment.

6.4 Backcasting Assistance/Factual Knowledge Use

Chapter four already illustrated backcasting reasoning using Moore's (2007) contribution. The goal of the gamestorming experiment is to mobilize knowledge *use* and abduction. The goal is also to create new BMF frameworks that integrate nature as an actor in BMF sketches and cast actors in roles, modeled with iStar 2.0, where they can design piecemeal changes through abduction or 'Getting there!' following Ehrenfeld's words. The debriefing period could lead to the creation of a supporting platform that lets new F Practices emerge.

Abduction is fallible; abduction is not about scientific truth but about getting things done (Moore, 2007; Ehrenfeld, 2005; Yoshikawa, 2009) so that life flourishes on earth. Per Yoshikawa (2009), decision-makers are too disciplined (in this case, blocked inside a discipline) to practice abduction. However, literature shows that abduction is closely linked to innovation, design, policy-formulation etc. (Liedtka, 2015; Patokorpi & Ahvenainen, 2009; Tomiyama et al., 2003). UML use case 3 already put a player in abductive reasoning mode by using the 12 sentences written by Moore (2007). This is a valid option, but larger gamestorming experiments on wider and more complex problems could take advantage of computer support.

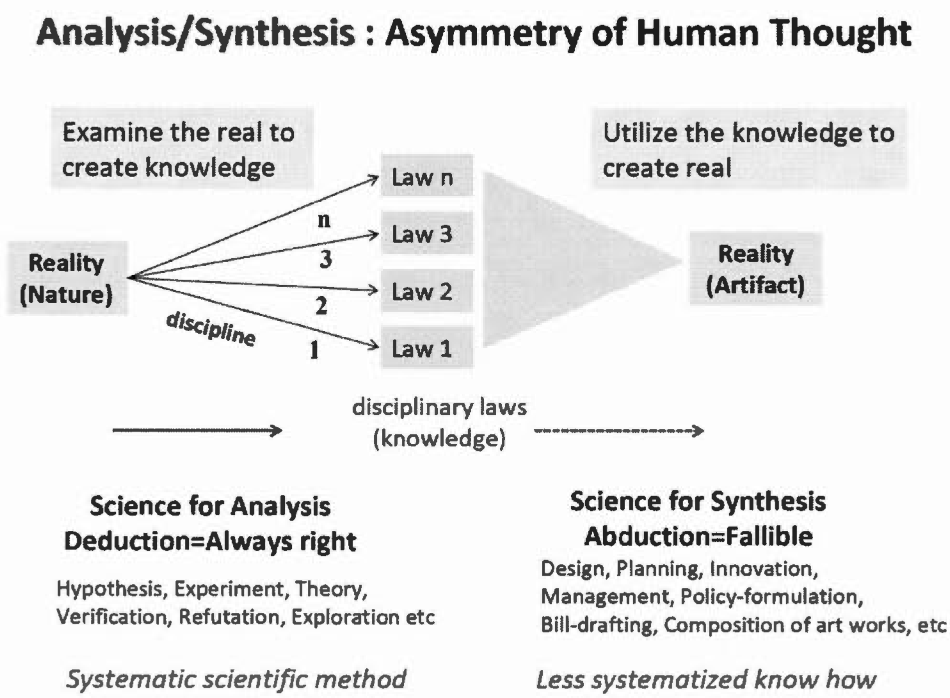

Figure 6.8 Analysis/Synthesis: Asymmetry of Human Thought

Source: Sustainability Science, Hiroyuki Yoshikawa, AIST, ICSS2009, February 6, 2009, University of Tokyo, p. 19.

Chapter three already presented sustainability science formal ontologies that could be combined with Universal Abduction Studio, which provides computerized assistance to designers.

6.4.1 Abduction Studio

Takeda et al. (2003) offer a universal abduction solution dedicated to support designers' activities (Figure 6.9). UAS is a computer environment to support integration of theories (that contain knowledge) from various knowledge domains for creative design. UAS is not a design automation system but a cooperation system that can solve design problems by helping dynamic interaction between a designer and the system. UAS provides a toolbox consisting of a variety of domain knowledge as well as a variety of abductive reasoning mechanisms for knowledge integration. When the designer cannot solve a design problem with the knowledge of one domain, the designer chooses a knowledge operation to make correspondences between that domain knowledge and another domain knowledge which UAS proposes. Then, the designer estimates and judges whether the proposed knowledge should be used. Finally, the designer generates design solutions based on the tentative design knowledge chosen by her/him (Takeda et al., 2003: Page 3).

This solution could help players when they are engaged in detailed problem-solving, if they need to compare their knowledge with—for example—sustainability science ontology. An alternative would be to have an option inside the game to spontaneously create a community where players declare their membership to other communities/hierarchies, get to know each other by sharing their profile and agree to comply with Moore's (2007) sentences.

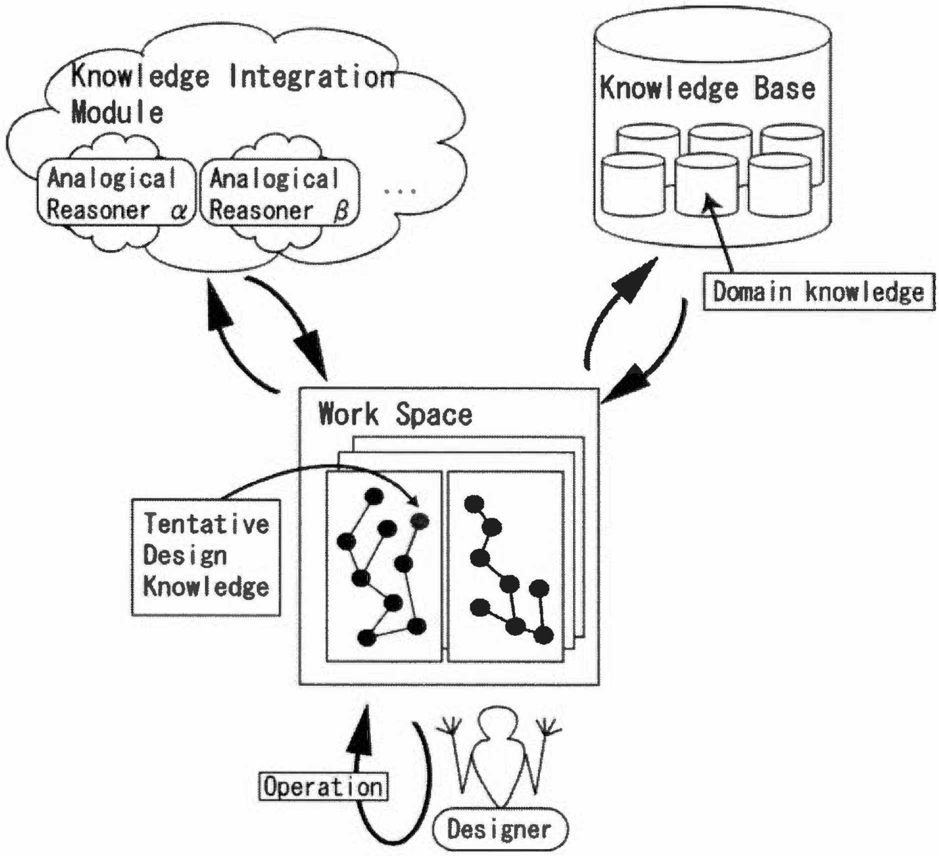

Figure 6.9 The Universal Abduction Studio

Source: Takeda et al., 2003

6.5 FAC Grid Exploration through Three Dialogues

There is a crucial distinction between a BMC as a closed design artifact and a BMF as an open design artifact: BMF design requires an *understanding* of the three materiality axes and of the collective creation of new BMF content and F Practices.

Lack of understanding about sustainability and lack of BM design capabilities were the main weaknesses identified in MIT's survey (see chapter one).

Table 6.5 SustAbdPLAY© Enabling Three Dialogues

	Techno-materiality		Socio-materiality		Physical Materiality	
Dialogue Focus	Value		Architecture		Physical Environment	
	Data	Discourse	Data	Vision	Data	Backcasting
Dialogue actors	Analysts	Business strategists, Investors, Share-holders	Business architects	Strategic apex	Environmental scientists, Activists	Business governance, Regional state governance, Eco-governance
Robot design: AI or CM?	AI		AI-CM		CM	
Data	Big Data		Mix		Small Data	
Cognitive science approach	Computation		Interpretation		Macrocognition—Situated cognition	
Sustainability status	Weak		Weak—Strong		'Flourishing'	
COGNITIVE SYSTEM LEVELS						
Representational	Factual and conceptual knowledge organized into a BM canvas		Factual, conceptual and procedural knowledge organized in architecture models		Factual, conceptual, procedural and metacognitive knowledge organized in patterns	
Functional	Create value		Design mechanisms		Conform to and enhance nature cycles	
Material	Market immateriality		Socio-materiality		Physical materiality	
Invariants and situation awareness	External invariants		External/internal invariants		Internal/external invariants	

Knowledge of the three materiality levels can be illustrated using a concrete-abstract dialogue for each axis: one about value (techno-materiality), one about organizational architecture (socio-materiality) and one about physical environment (physical materiality). SustAbdPLAY© will assist player interaction through those three dialogues.

6.5.1 Dialogues Along the Main Axes

SustAbdPLAY© should be able to process assumptions and constraints that stem from data patterns emerging from big data. This is because big data[56] and analytics "have rocketed to the top of the corporate agenda. Executives look with admiration at how Google, Amazon, and others have eclipsed competitors with powerful new business models that derive from an ability to exploit data" (Barton and Court, 2012).

An architecture robot should be able to ease dialogue between strategy statements to create/capture value and its implementation inside structure/processes/routines. It is a dialogue between cognition and routines when strategy is considered as a practice (Golsorkhi et al., 2006).

Furthermore, the value robot would be of use in experiments that could be designed in such a game context. To test the feasibility of such experiments, a new dialogue must be initiated between the strategic apex and business architects. This dialogue will be expectation driven (not data driven) and may lead to a strong sustainability stance.

[56] Abreu and Acker (2013) compared big and small data qualities. Their distinctions take into account numerous criticisms (Boyd and Crawford, 2011; Hilbert, 2013) made with respect to some overly enthusiastic big data proponents. The factors developed by Abreu and Acker (2013) are the following: *motivation*, *data collection*, *context*, *affect*, *archival engagement* and *retention*.

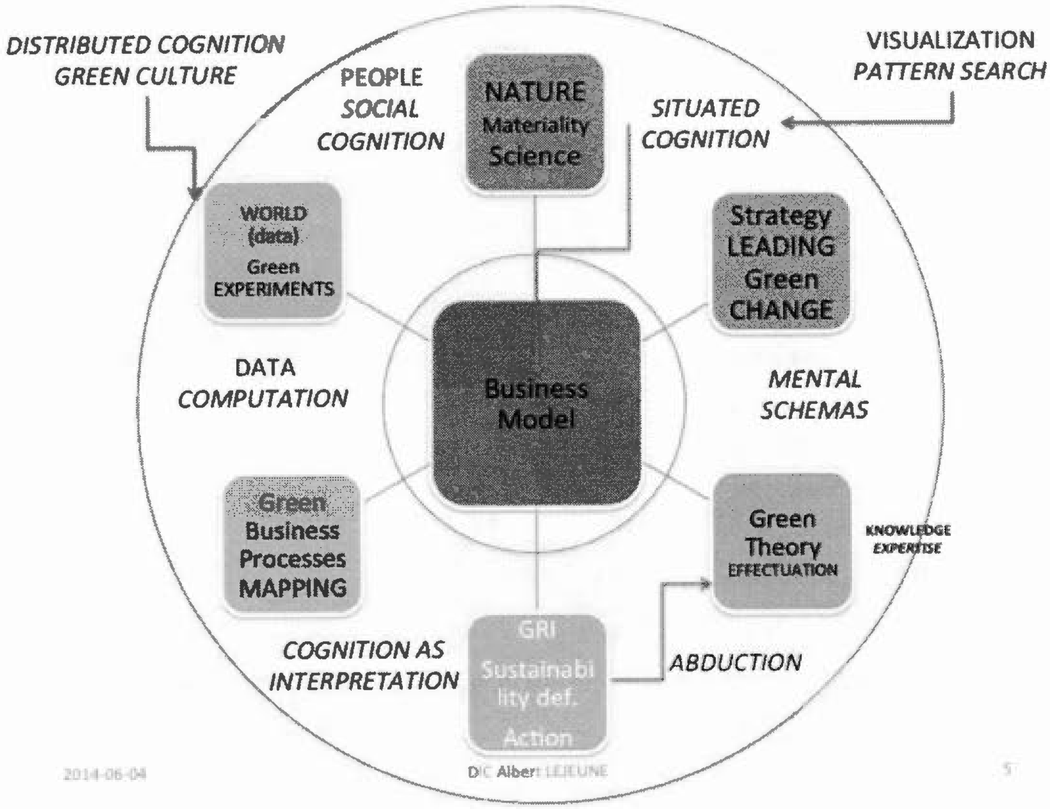

Figure 6.10 SustAbdPLAY©: Three Dialogues Around BMF

6.6 Conclusion

Chapter six is a high-level proposal for SustAbdPLAY©. The designer's idea is to keep the design light and simple by capitalizing on social conceptualization. Robots stop and move, perceiving new data—thereby creating new knowledge—by moving. During the Logim@s© experiment, the moving decision on the FAC grid may have been individually thought out and taken, but it can also be socially built by exchanging freely inside a community of wisdom. This is also a leitmotiv per Clancey (1997) who insists on the fact that if a robot acts as an artist it should be a member of the artistic community… or, at the very least, its designer should be!

SustAbdPLAY© won't explicitly and specifically help with conceptual or procedural knowledge about sustainability, with its dual archetype definition of sustainable development and GRI reporting procedures. The design concept is that a community of committed players should emerge, explore the facts and should try, via abduction, to devise new actions, design new practices or rewrite local storylines to change the future. Back to the Dakota protesters' case, we observe a will to change things[57] that defines a mental state shared across a community (macrocognition) vs. factual knowledge hiding a different will from the business hierarchy.[58] Neither sustainable development as conceptual knowledge nor GRI reporting practices as procedural knowledge can help here. This chapter brought together three ideas to design an efficient tutor, SustAbdPLAY©. First, it makes the proposal to apply iStar 2.0 running on piStar to elicit social and intentional knowledge about the players. Second, it borrows the Universal Abduction Studio from Takeda et al. (2003) as a means of assisting the backcasting posture while checking existing ontologies about

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[57] " 'We have to be here,' David Archambault II, the chairman of the Standing Rock Sioux tribe, who was arrested at the site last week, said in a statement. 'We have to stand and protect ourselves and those who cannot speak for themselves.' " (https://insideclimatenews.org/news/18082016/native-americans-sioux-tribe-protest-north-dakota-access-bakken-oil-pipeline-fossil-fuels, visited on November 14, 2016)

[58] "The pipeline's builder, Energy Transfer Partners, said through a spokesperson that it is 'constructing this pipeline in accordance with applicable laws, and the local, state and federal permits and approvals we have received.' " (https://insideclimatenews.org/news/18082016/native-americans-sioux-tribe-protest-north-dakota-access-bakken-oil-pipeline-fossil-fuels, visited on November 14, 2016)

sustainability science. Finally, the three FAC axes become three opportunities for dialogue where players interact with the intelligent tutor.

CHAPTER VII

CONCLUSION AND FUTURE RESEARCH

7.1 Introduction

Two inventions were the jumping off point for this thesis: an MBA classroom concept where a solution to a business case problem is worked out during a session in the spirit of reverse-learning and an original table game designed to be tested by managers and professionals; in both settings, a space game had to be invented and key artefacts developed, like websites or cards and the rules of the game. In this thesis, the path that led to these inventions was not discussed. Chapter one set up a BMs evolution from diverse literature sources on cognition, business models, artificiality and design science, sustainability and flourishing approaches, as well as concept development eventually leading to an FAC grid framework in chapter two.

After exposing this conceptual framework, chapter three took stock of an experiment in an MBA classroom where knowledge creation was guided by our ontologizing approach and mixed with traditional BMC in the Pinnacle West case. The experiment showed that BMC focalization limits move on an artificiality trajectory, constrain forms of cognition, new knowledge and logic on the cognition axis and limit exploration of the flourishing axis. However, stimulating group knowledge creation generated creative solutions outside the BMC framework and eased fluid navigation on the artificiality axis.

Chapter four presented the navigation on an artificiality trajectory experiment through a table game that included BMC, the LogiM@s© game. City sustainability managers are not used to working with the BMC approach, but they were invited to practice this approach to model the benefits of an infrastructure project constraint in different environmental discourses in four cities. Three of the city cases were borrowed from Moore's book (2007) describing sustainability processes in Austin, Curitiba and Frankfurt, and a Canadian city was added. In this setting we again observed that BMC focalization limits move on an artificiality trajectory, constrain new forms of cognition and limit exploration of the flourishing axis. Logim@s© gamestorming triggered fun through the learning process and augmented the quality of exchanges while easing navigation on the artificiality trajectory by connecting internal/external discourses and by adapting categories.

Chapter five laid out a general system design for SustAbd© as a gamestorming platform while, through UML use cases, the designer's role was modelled. Chapter six aimed at applying the cognitive modeling (CM) approach. The intention behind this chapter was not to automate BM innovation, but to better understand the role of a virtual tutor.

Logim@s© was based on Moore's (2007) analysis of sustainability adoption by various cities in the world and on observation of the logical reasoning mode of planners and decision-makers. One of the first approaches to sustainability in urban planning involves the deduction of proposals based on the principles of "Sustainability" as negotiated from 1985 to 1987 and presented in the Bruntdland

Report. Per Moore (2007), managers who reason with logical deduction construct idealized models, that is pre-political and "thin" models rather than "dense" models. These models are static, do not reflect the Bruntdland report (1987) and offer only one possible form of democracy: liberal capitalism. In a way, models and lists referring to sustainability can be useful as heuristic and analytical tools. However, they tend to suppress public speaking required to motivate action in a 'place.' In fact, following Moore (2007), sustainability models and lists are produced by social scientists who studied the past through rational methods of deduction (models) and induction (lists). However, planners and urban planners—in the study by Moore (2007)—seem to be much more productive than social scientists, generating a sustainable future using abduction as a logic design.[59]

7.2. Relevance of Contradictory Discourses as Change Drivers

Engeström and Sannino (2012) revised the work of some authors on "cognition in the wild," a topic opened by Hutchins. Among these authors, Engeström and Sannino (2012) quote Vygotsky (1987, 1997) and his theory of double stimulation. In the theory of double stimulation, the initial stimulus situation involves a conflict of motives. The conflict is resolved by invoking a neutral artefact as a second or auxiliary stimulus, which is turned into a mediating sign by investing it with

[59] For logicians, only the deductive approach can be equated with the label 'logic'; abduction is more about inferences than logic, which is seen as a discipline. Per Wikipedia: "Inferences are steps in reasoning, moving from premises to conclusions. Charles Sanders Peirce divided inference into three kinds: deduction, induction, and abduction. Deduction is inference deriving logical conclusions from premises known or assumed to be true,[1] with the laws of valid inference being studied in logic. Induction is inference from particular premises to a universal conclusion. Abduction is inference to the best explanation."

meaning. Vygotsky's theory of double stimulation offers a new architectural view of the Logim@s© game. Originally conceived to move sustainability ideas, definitions and discourses into the BMC framework, the game also happens to be a double stimulation toward building new BMF concepts. The fact that each city is presented with close to incompatible discourses generates tensions, confusion and frustration that can be identified with *stimulus 1* in Vygotsky's theory. The support cards and BMC form, in this case, *stimulus 2,* an artefact turned into a meaningful sign.

7.3 Discourses as Part of Artificiality Trajectory

BM or BMF design also builds discourse or performative representations: "A business model is a representation in that it is a text that redescribes and reconstructs reality—whether actual or imagined—in a way that is always partial, interested, and intent on persuading (De Cock, 2000)." (Perkmann and Spicer, 2010: p. 270)

BM, as an artefact, lies in the middle of Krippendorff's 'Trajectory of Artificiality' between customer interface and innovation project levels: "There is no need to force users to know what designers know about an artefact, but there are good reasons for designers to know the conceptions that users have available to approach the artefact they are asked to design. (Krippendorf, 2007: p. 18).

Table 7.1 integrates BM literature with business model innovation (BMI) literature to better illustrate the four ways of overcoming cognitive inertia.

Table 7.1 Sustainability Artificiality Trajectory and BMI

1. Product (EXPERI-MENTING)	2. Service (EXPERI-MENTING)	3. Customer interface (EXPERI-MENTING)	4. Innovation Network – BM (MAPPING)	5. Innovation Project (EFFECTU-ATION)	6. Discourses (LEADING CHANGE)

7.4 Abduction as Logical Mode

At one extremity (computation), the cognition axis in the FAC grid represents the analytical aspect of the scientific method: hypothesis, experiment and theory constitute the way science examines the real to create knowledge. At the other extremity (situated cognition, macrocognition), knowledge must be used to create a new reality through new artefacts. In this case, science is a science of synthesis using abduction as a logical mode to solve complex problems. With sustainability science, the work of Kumazawa et al. (2009) has designed the structure of knowledge and helps thinking in this direction. They focus on the challenges of structuring knowledge in the science of sustainability; they identify requirements for structuring knowledge while providing a reference model and developing a mapping tool based on ontology.

BMC on Web (search "business model canvas" on Google images, visited on April 17, 2015)

BMF on Web (search "flourishing business model" on Google images, visited on April 17, 2015)

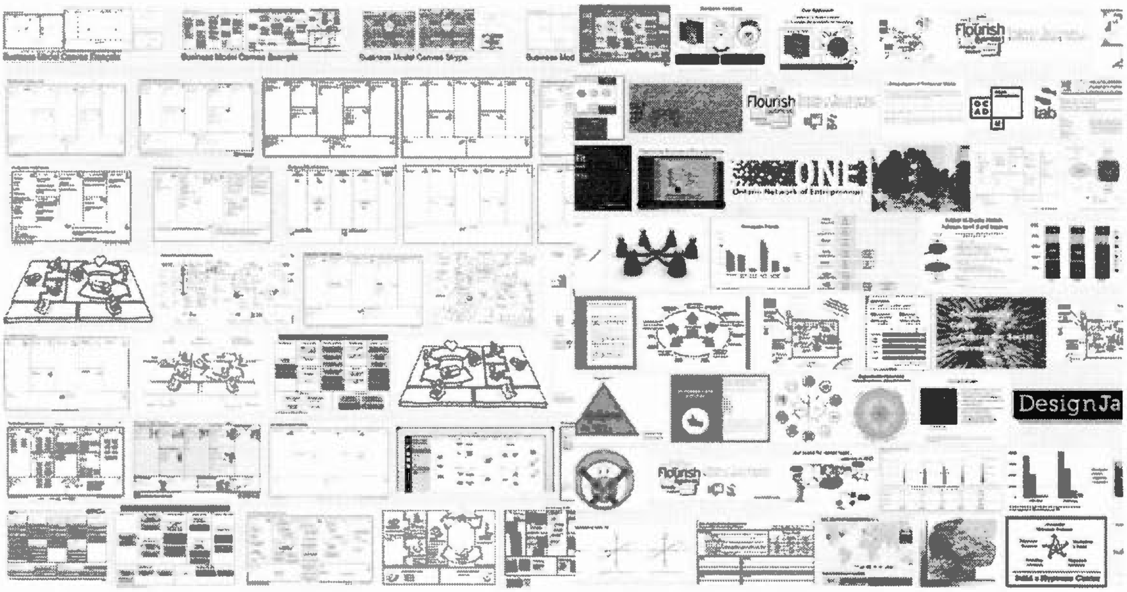

Figure 7.1 BMC and BMF Google Search Images

7.5 BMC and BMF as Conceptual Artefacts

As previously stated, BMs and BMFs are cognitive artefacts. Their nature is that of a designed object (and some designs are better than others), as an object playing a cognitive role (and therefore an object whose design must support this feature), as an external object with which we interact (and therefore part of the perspective of situated cognition) and as a public object that several people can use at the same time (and therefore part of the macrocognitive perspective). The concept of BMs and BMFs as cognitive artefacts could anchor everything we can say about BMFs from a cognitive point of view.

Search results identify one BMC on the left of Figure 7.1; multiple representations exist to describe BMFs. BMC design is 'thin' while BMF design is 'thick' due to the integration of socio- and physical materiality. The virtual tutor for BMF design faces multiple challenges (Table 7.2)

Comparison between BM and BMF tutoring illustrates two main problems in BMF design and implementation as identified by MIT studies (chapter one): capability to design and understanding of sustainability.

Table 7.2 Tutor Challenges and BMs/BMFs as Cognitive Artefacts

BMC	BMF
<u>Closed Design: BMC</u> Remember/understand nine BMC categories Nil Nil Apply BMC individually	<u>Open Design: BMF</u> Understand three materiality levels Collaborate to new BMF framework(s) Create new BMF framework(s) Create new BMF content collectively
<u>BM with Supporting Feature from External Invariants (e.g. BM theme)</u> Detect external invariants useful for BM/BMF design Shared discovery/evaluation of external invariants from technical to physical materiality Evaluate/create new external invariants (e.g. integrate Nature in BMF) Propose/evaluate piecemeal changes following materiality levels	<u>BMF with Supporting Feature from Subjective Invariants</u> Express subjective values & preferences about BMC/BMF Shared discovery/evaluation of subjective invariants Push actor's role in design through abduction Link piecemeal changes with inter-subjectivity and commitment

BM case under design Triggers value ($) seeking minds, knowledge creation Hierarchy of investors, shareholders, managers Model disconnected from activity system	BMF case under design Requires knowledge synthesis and use People contributing to new practices 'Getting there!' with Ehrenfeld's definition Motivating model
BMC as public object Commercial artefacts: canvases, books, software Nil Nil Objects remain unchanged	BMF as public object and platform for new F practices Public platform for F practices publishing Emerging community of people adhering to new BMF and publishing new F practices Supporting platform for abduction between actors inside (business) ecosystem Debriefing as source of new F practices for F platform

7.6 Future Research: Implementing the FAC Framework

Figure 7.2 is a reproduction of Figure 6.5, an intelligent environment for FAC framework. The following paragraphs illustrate how research on different FAC implementation modules could progress. A general criticism from evaluation committee members was that the FAC framework was underexplored, specifically on the cognition dimension. So, the first step would be to better describe mental states defining players' cognition modes from computation to macrocognition. Figure 7.3 illustrates a possible screen mixing iStar 2.0 using the piStar and creative design tools as in Horkoff & Maiden (2016).

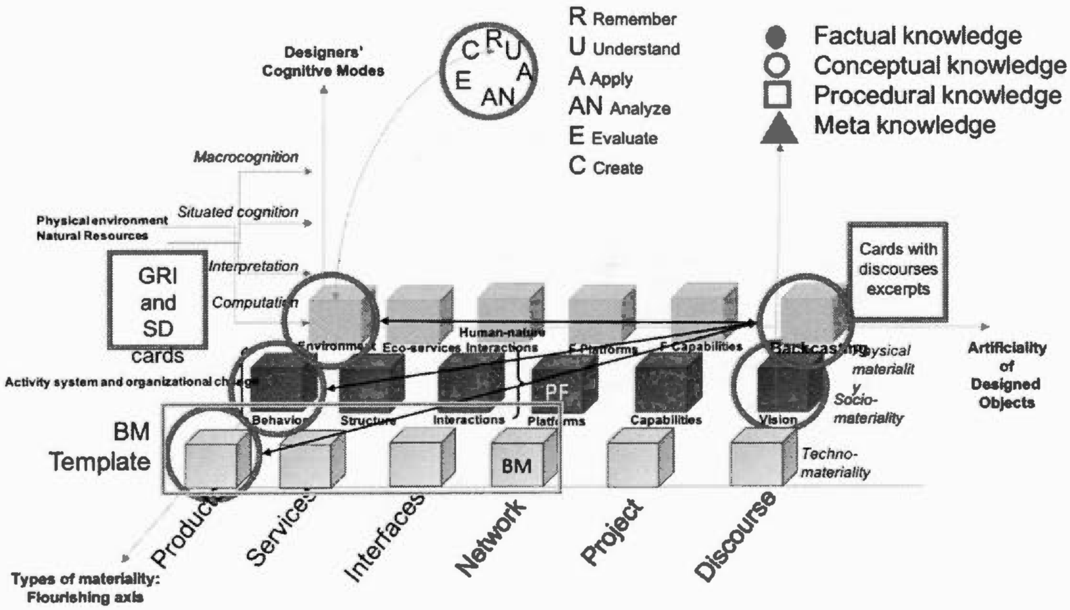

Figure 7.2 Improving the FAC Intelligent Environment

In Figure 7.3, players 11 and 21 are a basic representation of two actors' profiles. iStar enables representation of other actors like communities and hierarchies. So, a first step in future research would be to develop the ability to describe actors (individuals, organizations, systems) and, at the same time, connect them to specific cubes they are interacting with. Interacting with one or several cubes, an actor can read and modify data. SustAbdPLAY© will track those interactions to build a dedicated profile for each actor and actors' interactions.

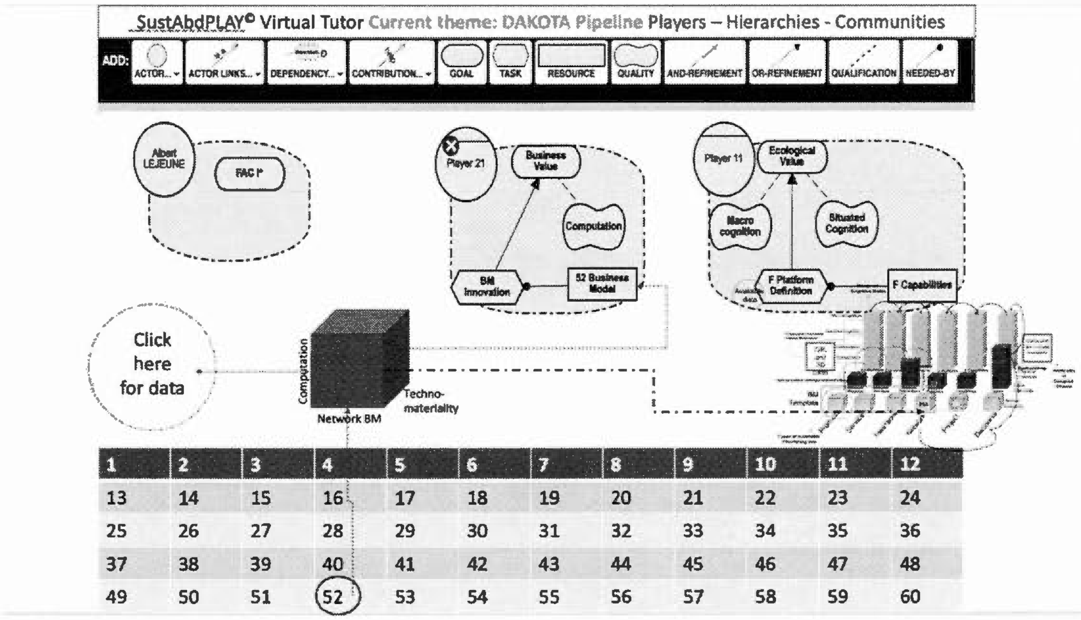

Figure 7.3 SustAbdPLAY© Screen Combining iStar 2.0 and FAC Cubes

In the next step, SustAbdPLAY© should be able to organize data in a meaningful way when a cube is open. A cube will relate to one of several actors at a specific time. Once its data are displayed on a screen, they may look like Figure 7.4. In this Figure, an actor is devising an action at a specific cognition level. Those actions or cognitive processes are generic as defined by Anderson et al (2001). From a specific cube, an action will aim at remembering (understanding etc.) data and information stored inside another cube or objects in Figure 7.4 that reuse the DMO approach presented in chapter three. As an example, scenario one (1) links players with backcasting and F Capabilities, while scenario two (2) links players with a BM through the verb 'create.'

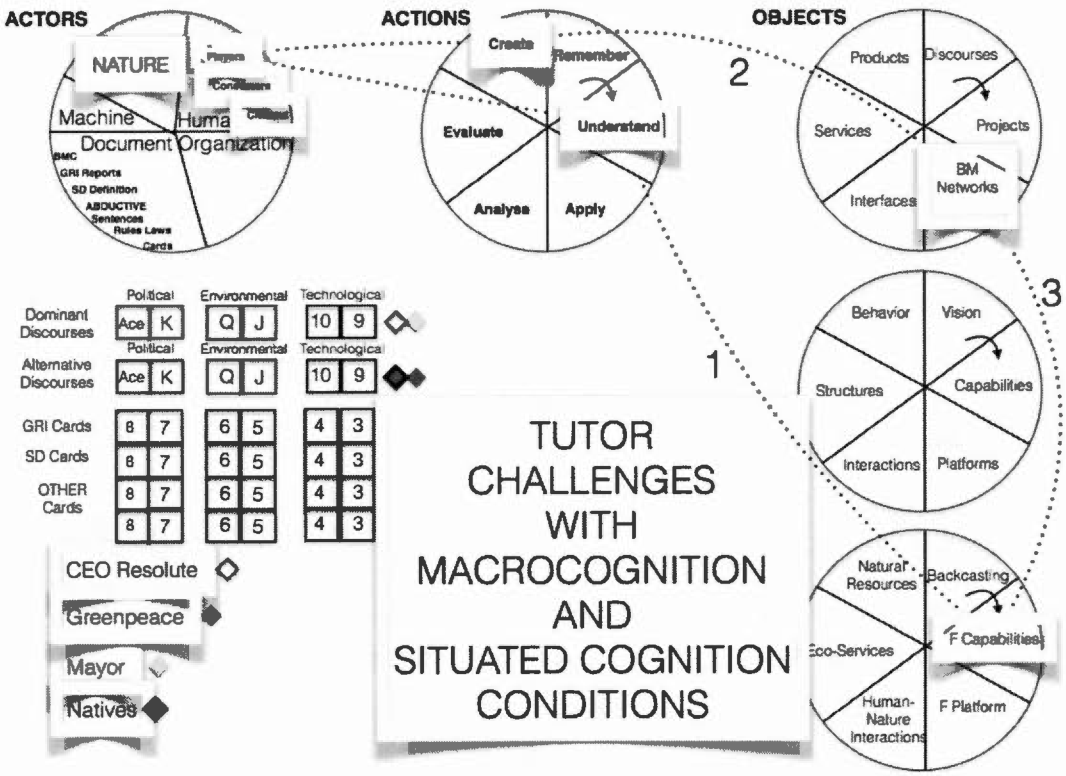

Figure 7.4 Displaying Data from Specific Cubes

In Figure 7.4, scenarios 1 and 2 parallel BMF tutoring with BM tutoring using Anderson's basic categories and insisting on:

- An understanding of the three materiality levels
- The importance of subjectivity and personal values expression
- The importance of knowledge synthesis and use
- The importance of sharing/publishing new F practices

When Nature (cube 1) plays a role as a new actor in BM(F) design, progressively BM design can no longer fit within a canvas or several canvases (Figure 7.1). BMF design begins to be a matter of community design where situated cognition and conditions for macrocognition are key.

A further critical step would be to adapt the Universal Abduction Studio (chapter six) to abductive inferences building inside the FAC framework. The challenge is to adapt the Universal Abduction Studio to individual players (at different cognition levels, engaged in distinct cognitive processes) and hierarchy and community players. In a 'place-based' context, they will use ontologies and their intelligent applications—like Sustainability Science ontology—to solve complex problems.

Finally, future research should:

- Experiment Logim@s© game with a new population, on multiple sites, in real time
- Enhance game functionalities
- Design original games from different table game models or from video games
- Develop gamestorming platform elements
- Connect platforms with sustainability science ontology
- Connect platforms with computer assisted abduction tools
- Experiment the approach on business ecosystem scale
- Develop the virtual tutor through player-tutor dialogues
- Monitor macrocognition conditions and ease social reasoning during the debriefing period.

7.7 Contribution of this Research, Limits and Conclusion

This research was mostly exploratory. The starting point was BMC gamestorming's popular success vs. field research surveys confirming that a BMF was a managerial challenge illustrating both a lack of design capabilities and a lack of understanding of sustainability. By opposing BMC 'thin' design and BMF 'thick' design, we introduced socio- and physical materiality to form the FAC grid which uses Krippendorff's 'Artificiality Trajectory.' Contrasting the way discourse tries to sell a new BM, vision proposes a new organizational architecture while backcasting identifies piecemeal changes leading actors to a desirable and flourishing future. These research propositions were developed and tested through course material and the development of an original game. From the observations that were made, a BMF gamestorming platform design was proposed with a virtual tutor definition designed to be a substitute for a human tutor.

This research neither creates nor proves any theory. The researcher used action research and kept a design science stance. However, gamestorming ideas emerged from numerous interactions in the field as well as a sound literature review at the intersection of BMs, sustainability and cognition.

Both the literature review and field research are the foundations of the FAC framework. SustAbd© development could use extant technologies like intelligent tutors, the Universal Abduction Studio, the Sustainability Science ontology created in Japan, much of the recently developed knowledge in new business models and sustainability and big data tools. However, free exchanges with professionals in real settings using simple table games seems to be a low-cost but high-return way to better define and build SustAbd©.

To end this chapter and this thesis, a few comments on research propositions presented in chapter 3 (Table 3.5), and reproduced in table 7.3. If those propositions were generated by this work, they are of course not validated. However, our conviction is that those propositions are a good start for people (managers, educators, game designers) searching to develop serious games to solve problems identified at

Table 7.3 Revised Summary of Research Propositions

VBM BMC-based design research propositions	**ABM with OA-SA design approach research propositions**	**BMF design approach research propositions**
Classical BM approach or the quest for a strategic drive. This drive can be more or less 'green' but the strategic mindset stays 'business as usual'.	New vision to develop new capabilities aiming at changing the business, the business ecosystem and society. Capabilities such as dematerializing or recycling and sharing lead to new 'sharing economy' or 'circular economy' through dedicated platforms.	Will and commitment to improve natural or physical environment state. Nature is an actor. There is a quest for new flourishing capabilities and practices to be shared inside or between business ecosystems.
A. VBM BMC-based thin design experiments tend to limit players/designers' moves on one axis: techno-materiality	A. ABM with OA-SA design experiments tend to limit players/designers' moves on two axes: techno-materiality and socio-materiality axes	A. BMF thick design experiments tend to extend players/designers' moves on three axes, i.e. techno-materiality, socio-materiality and physical materiality
B. VBM BMC-based thin design experiments tend to limit players/designers' focus on 'network' position on artificiality trajectory	B. ABM with OA-SA design experiments tend to limit players/designers' focuses on 'network' on artificiality trajectory and 'vision,' 'capability' and 'platform' on socio-materiality axis	B. BMF thick design experiments tend to multiply players/designers' moves from product to discourse, back and forth on techno-materiality axis; from behavior to vision, back and forth on socio-materiality axis; from physical environment state to backcasting,

		back and forth on physical materiality axis
C. VBM BMC-based thin design experiments tend to limit players/designers' cognitive modes to computation/interpretation in a hierarchical context with few powerful people	C. ABM with OA-SA design experiments tend to limit players/designers' cognitive modes to computation/interpretation in a societal context	C. BMF thick design experiments tend to extend roles and categories of players/designers' and their cognitive modes from computation, interpretation, to situated cognition and macrocognition
D. VBM BMC-based approach connects with sustainability issue(s) in a design stance	D. ABM with OA-SA design approach connects only indirectly with sustainability issue(s), in an intentional stance	D. BMF approach connects with sustainability issue(s) in a physical stance

the beginning of this research in the business world: lack of understanding of sustainability and weaknesses in the creation of new BMs.

Distinguishing between VBM, ABM and BMF is a first step toward new BM design. The other steps require a search for coherence between a BM type, a stance (Dennett, 1995), a cognitive mode and an understanding of the three materiality axes and their *modus operandi*: discourse or vision or backcasting.

BIBLIOGRAPHY

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., ... Wittrock, M. C. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, abridged edition. *White Plains, NY: Longman.*

Andrade, A., & de Carvalho, C. V. (2013). Gamifying a Serious Games Community. In *International Conference on Computer, Networks and Communication Enginnering (ICCNCE 2013)*, 249–252.

Antal, M., & Hukkinen, J. I. (2010). The art of the cognitive war to save the planet. *Ecological Economics*, *69*(5), 937–943.

Arnab, S., & Clarke, S. (2016). Towards a trans-disciplinary methodology for a game-based intervention development process. *British Journal of Educational Technology.* doi:10.1111/bjet.12377

Aydede, M., & Robbins, P. (2009). *The Cambridge handbook of situated cognition.* Cambridge University Press, New York, NY.

Baden-Fuller, C., & Morgan, M. S. (2010). Business Models as Models. *Long Range Planning*, *43*(2–3), 156–171.

Baldwin, C. Y., & Woodard, C. J. (2008). *The Architecture of Platforms: A Unified View* (SSRN Scholarly Paper No. ID 1265155). Rochester, NY: Social Science Research Network.

Bansal, P., & Hoffman, A. J. (2011). *The Oxford Handbook of Business and the Natural Environment.* Oxford University Press, New York, NY.

Bansal, P., & Knox-Hayes, J. J. (2013). The Time and Space of Materiality in Organizations and the Natural Environment. Organization & Environment. DOI: https://doi.org/10.1177/1086026612475069

Barton, D., & Court, D. (2012). Making advanced analytics work for you. Harvard Business Review, 90(10), 78–83.

Baskerville, R. L., & Wood-Harper, A. T. (2016). A Critical Perspective on Action Research as a Method for Information Systems Research. In L. P. Willcocks, C. Sauer, & M. C. Lacity (Eds.), *Enacting Research Methods in Information Systems: Volume 2* (pp. 169–190). Springer International Publishing.

Baskerville, R., & Myers, M. D. (2004). Special issue on action research in information systems: Making IS research relevant to practice: Foreword. *Mis Quarterly*, 329–335.

Ben-Zvi, T., & Carton, T. C. (2008). Simulation gaming in technology management. *AMCIS 2008 Proceedings*, 81.

Benn, S., & Martin, A. (2010). Learning and change for sustainability reconsidered: A role for boundary objects. *Academy of Management Learning & Education*, *9*(3), 397–412.

Bézivin. J. (2004). In search of a basic principle for model driven engineering. UPGRADE, Vol. V, No. 2, 21-24.

Bishop, I. D. (2011). Landscape planning is not a game: Should it be? *Landscape and Urban Planning*, *100*(4), 390–392.

Blanchard, E. G., & Ogan, A. (2010). Infusing cultural awareness into intelligent tutoring systems for a globalized world. In *Advances in Intelligent Tutoring Systems*, 485–505, Springer.

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56.

Bohnsack, R., Pinkse, J., & Kolk, A. (2014). Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. *Research Policy*, *43*(2), 284–300.

Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner Production*, *45*, 9–19.

Boons, F., Montalvo, C., Quist, J., & Wagner, M. (2013). Sustainable innovation, business models and economic performance: an overview. *Journal of Cleaner Production, 45*, 1–8.

Boulding, K. E. (1966). *Economic analysis* (Vol. 2). Harper & Row, New York, NY.

Bourdeau, J., & Grandbastien, M. (2010). Modeling tutoring knowledge. In *Advances in intelligent tutoring systems* (pp. 123–143). Springer.

Brundtland, G., & others. (1987). *Our common future: Report of the 1987 World Commission on Environment and Development*. Oxford: Oxford University Press.

Brynjolfsson, E., & Schrage, M. (2009). The new, faster face of innovation. *MITSloan Management Review*.

Bubenko Jr, J. A. (2007). From information algebra to enterprise modelling and ontologies—a historical perspective on modelling for information systems. In *Conceptual Modelling in Information Systems Engineering*, 1–18, Springer.

Byrch, C. Kearins, K. Milne, M. & Richard Morgan. (2007). Sustainable "what"? A cognitive approach to understanding sustainable development. *Qualitative Research in Accounting & Management*, *4*(1), 26–52.

Callon, M. (2009). Civilizing markets: Carbon trading between in vitro and in vivo experiments. *Accounting, Organizations and Society*, *34*(3–4), 535–548.

Callon, M., Millo, Y., & Muniesa, F. (2007). *Market Devices*. Blackwell.

Carlile, P. R., Nicolini, D., Langley, A., & Tsoukas, H. (2013). *How Matter Matters: Objects, Artifacts, and Materiality in Organization Studies*. Oxford University Press, New York, NY.

Chalandon, X. (2013). *Conscience de la situation : invariants internes et invariants* externes : Situation awareness - Monographie de la Conscience de la Situation, extraits du manuscrit de Doctorat d'Ergonomie « Conscience de la situation : invariants internes et invariants externes » soutenue le 2 mai 2007 (CNAM), Paris.

Checkland, P. (1985). From optimizing to learning: A development of systems thinking for the 1990s. Journal of the Operational Research Society, 36(9), 757–767.

Chesbrough, H. (2010). Business model innovation: opportunities and barriers. Long Range Planning, 43(2), 354–363.

Churcher, K. M., Downs, E., & Tewksbury, D. (2014). “Friending” Vygotsky: A Social Constructivist Pedagogy of Knowledge Building Through Classroom Social Media Use. The Journal of Effective Teaching, 33.

Ciborra, C., & Willcocks, L. (2006). The mind or the heart? It depends on the (definition of) situation. Journal of Information Technology, 21(3), 129–139.

Clancey, W. J. (1997). Situated Cognition: On Human Knowledge and Computer Representations. Cambridge University Press, New York, NY.

Clark, A. (2008). Supersizing the Mind: Embodiment, Action, and Cognitive Extension: Embodiment, Action, and Cognitive Extension. Oxford University Press, New York, NY.

Clark, W. C., & Dickson, N. M. (2003). Sustainability science: The emerging research program. Proceedings of the National Academy of Sciences, 100(14), 8059–8061.

Cock, C. D. (2000). Essay: Reflections on Fiction, Representation, and Organization Studies: An Essay with Special Reference to the Work of Jorge Luis Borges. Organization Studies, 21(3), 589–609.

Cohen, B., & Kietzmann, J. (2014). Ride On! Mobility Business Models for the Sharing Economy. Organization & Environment, 27(3), 279–296.

Copeland, T., Koller, T., & Murrin, J. (1990). Valuation. Measuring and managing the value of companies. McKinsey & Company, Inc.

Cowley, B., Moutinho, J. L., Bateman, C., & Oliveira, A. (2011). Learning principles and interaction design for “Green My Place”: A massively multiplayer serious game. *Entertainment Computing*, *2*(2), 103–113.

Cuddington, K. D. of B. S. Q. B. I., & Beisner, B. D. (2005). Rhetorical appeals to philosophy of science in ecology. In *ISHPSSB 2005 Meeting in Guelph.* International Society for the History, Philosophy, and Social Studies of Biology, University of Guelph, Guelph, Ontario, Canada.

Cusumano, M. A. (2014). How Traditional Firms Must Compete in the Sharing Economy. *Commun. ACM*, *58*(1), 32–34.

D’Mello, S., Lehman, B., Pekrun, R., & Graesser, A. (2014). Confusion can be beneficial for learning. *Learning and Instruction*, *29*, 153–170.

Dalpiaz, F., Franch, X., & Horkoff, J. (2016). iStar 2.0 Language Guide.

Damasio, A. R. (1999). The feeling of what happens: body and emotion in the making of consciousness. A Harvest Book Harcourt, Inc. New York, NY.

Davenport, T. H. (2011). Rethinking knowledge work: A strategic approach. *McKinsey Quarterly*, *1*(11), 88–99.

Davenport, T. H., & Kirby, J. (2016). Just How Smart Are Smart Machines? *MIT Sloan Management Review*, *57*(3), 21.

Davenport, T.H. (2009). How to Design Smart Business Experiments. *Harvard Business Review*. February.

de Jouvenel, B. (2009). L'économie politique de la gratuité (1957)*. *Futuribles*, (357), 75–86.

Dennett, D. C. (1995). Darwin's Dangerous Idea. *The Sciences*, *35*(3), 34–40.

Dennett, D. C. (1998). *Brainchildren: Essays on designing minds*. MIT Press.

Dennett, D.C. (1988). Précis of The Intentional Stance, *Behavioral and Brain Sciences*, 11 (3), 495-505.

Deterding, S., Björk, S. L., Nacke, L. E., Dixon, D., & Lawley, E. (2013). Designing gamification: creating gameful and playful experiences. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems*, ACM, 3263–3266.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, ACM, 9-15.

Doganova, L., & Eyquem-Renault, M. (2009). What do business models do? Innovation devices in technology entrepreneurship. *Research Policy*, *38*(10), 1559–1570.

Doz, Y. L., & Kosonen, M. (2010). Embedding Strategic Agility: A Leadership Agenda for Accelerating Business Model Renewal. *Long Range Planning*, *43*(2–3), 370–382.

Drucker, P. (1994). The Theory of Business. *Harvard Business Review*. September-October.

Ehrenfeld, J. (2008). *Sustainability by Design: A Subversive Strategy for Transforming Our Consumer Culture*. Yale University Press, New Haven, CT.

Ehrenfeld, J., & Hoffman, A. (2013). *Flourishing: A Frank Conversation about Sustainability*. Stanford University Press, Redwood, CA.

Elsbach, K. D., Barr, P. S., & Hargadon, A. B. (2005). Identifying situated cognition in organizations. *Organization Science*, *16*(4), 422–433.

Engeström, Y. (2004). New forms of learning in co-configuration work. *Journal of Workplace Learning*, *16*(1/2), 11–21.

Engeström, Y., & Sannino, A. (2012). Concept formation in the wild. *Mind, Culture, and Activity*, *19*(3), 201–206.

Etzion, D., & Ferraro, F. (2010). The Role of Analogy in the Institutionalization of Sustainability Reporting. *Organization Science*, *21*(5), 1092–1107.

Eyquem-Renault, M. (2011, December 6). Analyse pragmatique du business model et *performations de marché dans l'entrepreneuriat technologique*, Ph.D. Thesis. École Nationale Supérieure des Mines de Paris, Paris.

Falbo, R. de A., Ruy, F. B., Guizzardi, G., Barcellos, M. P., & Almeida, J. P. A. (2014). Towards an enterprise ontology pattern language. In *Proceedings of the 29th Annual ACM Symposium on Applied Computing*, ACM, 323-330.

Fransman, M. (2010). *The new ICT ecosystem: Implications for policy and regulation*. Cambridge University Press, Cambridge, UK.

Fritscher, B., & Pigneur, Y. (2010). Supporting Business Model Modelling: A Compromise between Creativity and Constraints. In D. England, P. Palanque, J. Vanderdonckt, & P. J. Wild (Eds.), *Task Models and Diagrams for User Interface Design* (pp. 28–43). Springer Berlin Heidelberg.

Gagné, R., Briggs, L., & Wagner, W. (1992). *Principles of Instructional Design (4th Ed.)*. HBJ College Publishers, Fort Worth, TX.

Garrett Millikan, R. (1984). Naturalist Reflections on Knowledge. *Pacific Philosophical Quarterly Anc Personalist (The) Los Angeles, Cal.*, *65*(4), 315–334.

Georgescu-Roegen, N. (1971). *The entropy law and the economic process*. Harvard University Press, Cambridge, Mass.

Georgescu-Roegen, N. (1977). The steady state and ecological salvation: a thermodynamic analysis. *BioScience*, *27*(4), 266–270.

Georgescu-Roegen, N. (2002). Four challenges of sustainability. *Conservation Biology, 16*(6), 1457–1460.

Ghaziani, A., & Ventresca, M. J. (2005). Keywords and Cultural Change: Frame Analysis of Business Model Public Talk, 1975–2000. *Sociological Forum, 20*(4), 523–559.

Giannetto, D., Chao, J., & Fontana, A. (2013). Gamification in a social learning environment. *Issues in Informing Science & Information Technology, 10*, 195–207.

Gibson, J. J. (2014). *The Ecological Approach to Visual Perception: Classic Edition*. Psychology Press.

Giusti, L., Pollini, A., Brunnberg, L., & Casalegno, F. (2012). En Plein Air: a mobile learning approach for sustainability education in the wild. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, 4(2), 44–58.

Goel, V. (2014). Creative brains: designing in the real world†. *Frontiers in Human* Neuroscience, 8. https://doi.org/10.3389/fnhum.2014.00241

Goleman, D. (2009). *Ecological Intelligence: How Knowing the Hidden Impacts of What We Buy Can Change Everything*. Broadway Books, New York, NY.

Gomez, M.-L., & Lorino, Philippe. (2005). The passion for inquiry: The contribution of abduction for research on organizational knowledge and learning. *The Passion for Learning and Knowing, 1*, 635–656.

Gonzalez, M. E. Q., & Haselager, W. P. F. G. (2005). Creativity: Surprise and abductive reasoning. *Semiotica, 2005*(153–1/4), 325–342.

Gordijn, J. (2002). E3-value in a Nutshell. In *International Workshop On E-Business Modeling, HEC Business School.*

Graesser, Art; Ozuru, Yasuhiro; Sullins, Jeremiah,McKeown, Margaret G. (Ed); Kucan, Linda (Ed). (2010). What is a good question? Bringing reading research to life, 112-141, New York, NY, US: Guilford Press, xvi, 320 pp.

Graetz, F. (2000). Strategic change leadership. *Management Decision, 38*(8), 550–564.

Gray, D., Brown, S., & Macanufo, J. (2010). *Gamestorming: A playbook for innovators, rulebreakers, and changemakers*. O'Reilly Media, Inc, Sebastopol, CA.

Haag, D., & Kaupenjohann, M. (2001). Parameters, prediction, post-normal science and the precautionary principle—a roadmap for modelling for decision-making. *Ecological Modelling, 144*(1), 45–60.

Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2016). How Circular Is the Global Economy? A Sociometabolic Analysis. In H. Haberl, M. Fischer-Kowalski, F. Krausmann, & V. Winiwarter (Eds.), *Social Ecology*, 259–275, Springer International Publishing.

Hamel, G. (2009). Moon shots for management. *Harvard Business Review*, *87*(2), 91–98.

Harnad, S. (2003). Minds, machines and Turing. In *The Turing Test*, 253–273, Springer.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, *20*(4), 986–1014.

Harvey, P.-L., & Lemire, G. (2002). *La nouvelle éducation, NTIC, transdisciplinarité et communautique*, L'Harmattan, Paris.

Haugh, H. M., & Talwar, A. (2010). How do corporations embed sustainability across the organization? *Academy of Management Learning & Education*, *9*(3), 384–396.

Huebner, B. (2013). Socially embedded cognition. *Cognitive Systems Research*, *25*, 13–18.

Huebner, B. (2014). *Macrocognition: A Theory of Distributed Minds and Collective Intentionality*. Oxford University Press, New York, NY.

Hutchins, E. (1995). *Cognition in the Wild.* MIT Press, Boston, Mass.

Jacobsson, S., & Lauber, V. (2006). The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy*, *34*(3), 256–276.

Johannsdottir, L. (2014). Transforming the linear insurance business model to a closed-loop insurance model: a case study of Nordic non-life insurers. *Journal of Cleaner Production*, *83*, 341–355.

Johnson-Laird, P. N. (1980). Mental models in cognitive science. *Cognitive Science*, *4*(1), 71–115.

Jonassen, D. H. (2010). *Learning to Solve Problems: A Handbook for Designing Problem-Solving Learning Environments*. Routledge.

Jonassen, D.H. (2011). Supporting Problem Solving in PBL. *Interdisciplinary Journal of Problem-Based Learning*, *5*(2).

Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review*, 1449–1475.

Kajikawa, Y. (2008). Research core and framework of sustainability science. Sustainability *Science*, *3*(2), 215–239.

Karray, F., & Silva, C. D. (2004). *Soft Computing and Tools of Intelligent Systems Design: Theory and Applications*. Pearson Addison Wesley.

Kearney, A. R. (1994). Understanding global change: a cognitive perspective on communicating through stories. *Climatic Change*, *27*(4), 419–441.

Khaled, R., Nelson, M. J., & Barr, P. (2013). Design metaphors for procedural content generation in games. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1509–1518). ACM.

Kilov, H. (2002). *Business Models: A Guide for Business and IT*. Pearson Education.

Klang, D., Wallnöfer, M., & Hacklin, F. (2014). The Business Model Paradox: A Systematic Review and Exploration of Antecedents. *International Journal of* Management Reviews, 16: 454–478. doi:10.1111/ijmr.12030

Knox-Hayes, J. (2014). *Techno-Materiality, Culture, and Climate Change: Japan and the Bilateral Carbon Offsetting Mechanism*. Presented at the XVIII ISA World Congress of Sociology (July 13-19, 2014), Isaconf.

Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education*, *4*(2), 193–212.

Komiyama, H., & Takeuchi, K. (2006). Sustainability science: building a new discipline. *Sustainability Science*, *1*(1), 1–6.

Krajcik, J. S., & Blumenfeld, P. (2006). *Project-based learning. The Cambridge Handbook of the Learning Sciences*. Cambridge University Press, Cambridge, UK.

Krippendorff, K. (1997). A Trajectory of Artificiality and New Principles of Design for the Information Age. *Design in the Age of Information, A Report to the National Science Foundation (NSF)*, 91–96.

Krippendorff, K. (2007). An Exploration of Artificiality. *Artifact*, *1*(1), 17–22.

Krogstie, J., Opdahl, A. L., & Brinkkemper, S. (2007). *Conceptual modelling in information systems engineering*. Springer.

Kumazawa, T., Saito, O., Kozaki, K., Matsui, T., & Mizoguchi, R. (2009). Toward knowledge structuring of sustainability science based on ontology engineering. *Sustainability Science*, *4*(1), 99–116.

Lamoreaux, N. R., Raff, D. M., & Temin, P. (2002). *Beyond markets and hierarchies: Toward a new synthesis of American business history*. National Bureau of Economic Research.

Land, S. M. (2000). Cognitive requirements for learning with open-ended learning environments. *Educational Technology Research and Development*, *48*(3), 61–78.

Lant, T. K., & Shapira, Z. (2000). *Organizational Cognition: Computation and Interpretation*. Psychology Press.

Larsen, L. J. (2012). A new design approach to game-based learning. Journal of Interactive *Learning Research*, *23*(4), 313–323.

Laszlo, C., Brown, J., Robson, L., Saillant, R., & Sherman, D. (2014). *Flourishing Enterprise: The New Spirit of Business*. Stanford University Press, Sebastopol, CA.

Latour, B. (2008). A cautious Prometheus? A few steps toward a philosophy of design (with special attention to Peter Sloterdijk). In *Proceedings of the 2008 annual international conference of the Design History Society*, 2–10.

Lavin, S. (2014). *Towards an understanding of business design within enterprise architecture management: a cautionary tale*. Ph.D. Thesis, University of Cape Town.

Lejeune, A. (2012). Business Model Innovation with Weak or Strong Sustainability In Mind. Paper presented at the ISPIM, *International Society for Professional Innovation Management*, Barcelona, Spain, June 17-20.

Lejeune, A. (2012). Green Organizational Architecture: What Could It Be? Paper presented at the *Workshop on Information and Organizational Architecture* (dirs.: Prof. Richard M. Burton and prof. Charles C. Snow), EIASM, Brussels, Belgium, March 19-20.

Lejeune, A., & Sack, I. (2011). From the Architect to the Organisational Architect: Modelling Organisational Domains in The Empty, Programming or Inhabited Space of Strategy. *International Journal of Work Organisation and Emotion*, *4*(1), 99–112.

Lejeune, A. Poirier, P. (2016). Business Models as Cognitive Artefacts, *New Business Models Conference*, Toulouse, Toulouse Business School, June 14-16.

Lejeune, A. Poirier, P. (2014). 'Green' Business Model Design: A Concept of Three Dialoguing Robots, *The ISPIM Americas Innovation Forum 2014*, Montreal, Canada, October 5-8.

Lejeune, A. Nkambou, R. (2013). A Table Game to Elicit Green Capacities in Business Models, *The XXIV ISPIM Conference – Innovating in Global Markets: Challenges for Sustainable Growth*, Helsinki, Finland, June 16-19.

Leonardi, P. M. (2012). *Materiality, Sociomateriality, and Socio-Technical Systems: What Do These Terms Mean? How are They Related? Do We Need Them?* (SSRN Scholarly Paper No. ID 2129878). Social Science Research Network, Rochester, NY.

Liedtka, J. (2015). Perspective: Linking Design Thinking with Innovation Outcomes through Cognitive Bias Reduction. *Journal of Product Innovation Management, 32*(6), 925–938.

Lillehagen, F., & Krogstie, J. (2008). *Active knowledge modeling of enterprises.* Springer Science & Business Media.

Lindgren, R., Henfridsson, O., & Schultze, U. (2004). Design Principles for Competence Management Systems: A Synthesis of an Action Research Study. *MIS Quarterly*, 435–472.

Lüdeke-Freund, F. (2009). Business Model Concepts in Corporate Sustainability Contexts: From Rhetoric to a Generic Template for 'Business Models for Sustainability'. *Centre for Sustainability Management (CSM), Leuphana Universität Lüneburg, ISBN*, 978–3.

Marcotullio, P. J., & Solecki, W. (2013). What Is a City? An Essential Definition for Sustainability. In C. G. Boone & M. Fragkias (Eds.), *Urbanization and Sustainability*, 11–25, Springer Netherlands.

Marsh, T. (2011). Serious games continuum: Between games for purpose and experiential environments for purpose. *Entertainment Computing*, *2*(2), 61–68.

Martin, R. L. (2009). *The Design of Business: Why Design Thinking is the Next Competitive Advantage*. Harvard Business Press.

Mercier, H., & Sperber, D. (2009). Intuitive and reflective inferences. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1862670

Monteiro, P., & Nicolini, D. (2015). Recovering Materiality in Institutional Work Prizes as an Assemblage of Human and Material Entities. *Journal of Management Inquiry*, *24*(1), 61–81.

Moore, S. A. (2007). *Alternative routes to the sustainable city: Austin, Curitiba, and Frankfurt*. Lexington Books, Toronto, ON.

Morabito, J., Sack, I., & Bhate, A. (1999). *Organization Modeling: Innovative Architectures for the 21st Century*. Prentice Hall.

Morales, J. M., Navarro, E., Sánchez, P., & Alonso, D. (2015). A controlled experiment to evaluate the understandability of KAOS and i* for modeling Teleo-Reactive systems. *Journal of Systems and Software, 100*, 1–14.

Muniesa, F., Millo, Y., & Callon, M. (2007). An introduction to market devices. *The Sociological Review, 55*, 1–12

Neander, K. (1991). *The Teleological Notion of Function*. Australasian Association of Philosophy.

Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why sustainability is now the key driver of innovation. *Harvard Business Review, 87*(9), 56–64.

Nielsen, K. A., Elling, B., & Jelsoe, E. (2010). *A new agenda for sustainability*. Ashgate Pub Co.

Nilsen, H. R. (2010a). *From Weak to Strong Sustainable Development. An analysis of Norwegian economic policy tools in mitigating climate change.* (Ph.D. Thesis). Bodø Graduate School of Business, Norway.

Nilsen, H. R. (2010b). The joint discourse "reflexive sustainable development" — From weak towards strong sustainable development. *Ecological Economics, 69*(3), 495–501.

Ning, D. (2001). Cleaner Production, Eco-industry and Circular Economy [J]. *Research of Environmental Sciences, 6*(0).

Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press, New York, NY.

Nooteboom, B. (2009). *A Cognitive Theory of the Firm: Learning, Governance and Dynamic Capabilities*. Edward Elgar Publishing.

Nubiola, J. (2005). Abduction or the Logic of Surprise. *Semiotica, 2005*(153–1/4), 117–130.

Orlikowski, W. J. (2009). The sociomateriality of organisational life: considering technology in management research. Cambridge Journal of Economics. doi: 10.1093/cje/bep058

Osterwalder, A. (2004). The Business Model Ontology-a proposition in a design science approach. *Academic Dissertation, Université de Lausanne, École Des Hautes Études Commerciales*.

Osterwalder, A. and Pigneur, Y. (2002). "An eBusiness Model Ontology for Modeling eBusiness" BLED 2002 Proceedings. Paper 2. http://aisel.aisnet.org/bled2002/2

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook For Visionaries, Game Changers, And Challengers*. Wiley.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems*, *16*(1), 1.

Overbeek, S., Frank, U., & Köhling, C. (2015). A language for multi-perspective goal modelling: Challenges, requirements and solutions. *Computer Standards & Interfaces*, *38*, 1–16.

Paavola, S. (2004). Abduction as a Logic and Methodology of Discovery: The Importance of Strategies. *Foundations of Science*, *9*(3), 267–283.

Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor–An emergent epistemological approach to learning. *Science & Education*, *14*(6), 535–557.

Passet, R. (1979). *L'économique et le vivant* (Vol. 23). Payot.

Passet, R. (2011). *Les grandes représentations du monde et de l'économie à travers l'histoire: De l'univers magique au tourbillon créateur*. Éditions Les Liens qui libèrent.

Patokorpi, E., & Ahvenainen, M. (2009). Developing an abduction-based method for futures research. *Futures*, *41*(3), 126–139.

Perkmann, M. & Spicer, A. (2010). What are business models? Developing a theory of performative representations. In *Technology and Organization: Essays in Honour of Joan Woodward* (29, 265–275). Emerald Group Publishing Limited.

Peschl, M. F., & Fundneider, T. (2014). Designing and Enabling Spaces for collaborative knowledge creation and innovation: From managing to enabling innovation as socio-epistemological technology. *Computers in Human Behavior*, *37*, 346–359.

Phillips, S. J., Dudík, M., & Schapire, R. E. (2004). A Maximum Entropy Approach to Species Distribution Modeling. In *Proceedings of the Twenty-first International Conference on Machine Learning* (p. 83–). ACM, New York, NY.

Psyché, V., Bourdeau, J., Nkambou, R., & Mizoguchi, R. (2005). Making Learning Design Standards Work with an Ontology of Educational Theories, 539–546. Presented at the 12th Artificial Intelligence in Education (AIED2005), IOS Press.

Rellihan, M. J. (2009). Fodor's riddle of abduction. *Philosophical Studies, 144*(2), 313–338.

Ribeiro, T., Pereira, A., Deshmukh, A., Aylett, R., & Paiva, A. (2014). I'm the mayor: a robot tutor in enercities-2. In *Proceedings of the 2014 international conference on Autonomous agents and multi-agent systems* (pp. 1675–1676). International Foundation for Autonomous Agents and Multiagent Systems.

Roome, N. (2012). A cybernetic model of corporate responsibility--sensing changes in business and society. *International Journal of Technology Management, 60*(1), 4–22.

Roos, G. (2014). Business Model Innovation to Create and Capture Resource Value in Future Circular Material Chains. *Resources, 3*(1), 248–274.

Rosario, R. A. M., & Widmeyer, G. R. (2009). An exploratory review of design principles in constructivist gaming learning environments. *Journal of Information Systems Education, 20*(3), 289.

Ross, J. W., Weill, P., & Robertson, D. (2006). *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press.

Sack, I. (2008, January 24). A New Contract Continuum for Organizational Design, PPT., Conference DIC UQAM.

Sarasvathy, S. D. (2008). *Effectuation: Elements of Entrepreneurial Expertise (New Horizons in Entrepreneurship). Cheltenham/Camberley (UK) and Northampton.* Edward Elgar Publishing.

Sauer, C., & Willcocks, L. P. (2002). The evolution of the organizational architect. *MIT Sloan Management Review, 43*(3), 41–49.

Savage, C. M. (1990). *Fifth Generation Management: Integrating Enterprises Through Human Networking* (1st Edition). Digital Pr., Bedford, Mass.

Sawyer, R. K. (2005). *The Cambridge Handbook of the Learning Sciences*. Cambridge University Press.

Scardamalia, M., & Bereiter, C. (2006). *Knowledge building: Theory, pedagogy, and technology*. Cambridge University Press.

Seidewitz, E. (2003). What models mean. *Software, IEEE, 20*(5).

Seni, D. A. (2013). *Analyse stratégique et avantage concurrentiel*. PUQ.

Shimomura, Y., & Kimita, K. (2012). *The Philosopher's Stone for Sustainability: Proceedings of the 4th Cirp International Conference on Industrial Product-service Systems, Tokyo, Japan, November 8th - 9th, 2012*. Springer Science & Business Media.

Shrivastava, P. (2010). Pedagogy of passion for sustainability. *Academy of Management Learning & Education, 9*(3), 443–455.

Simon, H. A. (1996). *The Sciences of the Artificial*. MIT Press.

Simon, P. (2011). *The age of the platform*. eBook.

Smith, A. M. (2009). The Intelligent Game Designer: Game Design as a New Domain for Automated Discovery, Thesis proposal, Dep. Of Computer Science, University of California, Santa Cruz, CA.

Sperber, D., & Mercier, H. (2010). *Reasoning as a Social Competence* (SSRN Scholarly Paper No. ID 1862669). Rochester, NY: Social Science Research Network.

Stachowiak, H. (1973). *Allgemeine Modelltheorie*. Springer-Verlag, Wien.

Starks, K. (2014). Cognitive behavioral game design: a unified model for designing serious games. Frontiers in Psychology, 5, 28. http://doi.org/10.3389/fpsyg.2014.00028

Susman, G. I., & Evered, R. D. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly*, 582–603.

Takeda, H., Sasaki, H., Nomaguchi, Y., Yoshioka, M., Shimomura, Y., Tomiyama, T., & others. (2003). Universal abduction studio-proposal of a design support environment for creative thinking in design. In *DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm*.

Tchounikine, P. (2009). Précis de recherche en ingénierie des EIAH. 109 p.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350.

Teece, D. J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, *43*(2–3), 172–194.

Thorelli, H. B. (1986). Networks: between markets and hierarchies. *Strategic Management Journal*, *7*(1), 37–51.

Tirole, Jean. (2016). *Économie du bien commun*. Paris : Presses Universitaires de France.

Tollefsen, D. (2002). Organizations as true believers. *Journal of Social Philosophy*, *33*(3), 395–410.

Tomiyama T, Takeda H, Yoshioka M, Shimomura Y. Abduction for Creative Design. ASME. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, *Volume 3b: 15th International Conference on Design Theory and Methodology* :543-552. doi:10.1115/DETC2003/DTM-48650.

Torres, M., & Macedo, J. (2000). Learning Sustainable Development with a New Simulation Game. *Simulation & Gaming*, *31*(1), 119–126.

Van de Ven, A. H. (2007). *Engaged scholarship: a guide for organizational and social research: a guide for organizational and social research*. Oxford University Press.

Vygotsky, L. S. (1987). Thinking and speech. *The Collected Works of LS Vygotsky*, *1*, 39–285.

Wang, M., Wu, B., Chen, N.-S., Spector, J. M., & others. (2013). Connecting problem-solving and knowledge-construction processes in a visualization-based learning environment. *Computers & Education*, *68*, 293–306.

Winn, M. I., & Pogutz, S. (2013). Business, Ecosystems, and Biodiversity: New Horizons for Management Research. *Organization & Environment*. Volume: 26 issue: 2, 203-229. Article first published online: May 26, 2013; Issue published: June 1, 2013. DOI: https://doi.org/10.1177/1086026613490173

Woolf, B. P. (2010). *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning*. Morgan Kaufmann.

Wu, Y.-C. J., Huang, S., Kuo, L., & Wu, W.-H. (2010). Management Education for Sustainability: A Web-Based Content Analysis. *Academy of Management Learning & Education*, *9*(3), 520–531.

Yoshikawa, H. (2009, February 6). Sustainability Science, AIST, ICSS2009, PPT. University of Tokyo.

Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic Management Journal*, *29*(1), 1–26.

Zott, C., & Amit, R. (2010). Business model design: an activity system perspective. *Long Range Planning*, *43*(2), 216–226.